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MANUAL

OF THE

DISSECTION OF THE HUMAN BODY

HOLDEN'S MANUAL

OF THE

DISSECTION OF THE HUMAN BODY

EDITED BY

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ILLUSTRATED WITH NUMEROUS WOOD ENGRAVINGS

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TO

THE STUDENTS

OF

ST BARTHOLOMEW'S HOSPITAL

IN THE HOPE THAT IT MAY ASSIST THEM IN THEIR ANATOMICAL STUDIES

This Manual is Dedicated

BY THEIR FAITHFUL FRIEND AND WELL-WISHER

THE AUTHOR

PREFACE

TO

THE FOURTH EDITION.

IN THIS EDITION the Editors have most carefully revised the entire work. The order of dissection has been here and there altered; and further illustrations and additional matter introduced, especially concerning the Anatomy of the Nervous System and the Senses.

The object throughout has been to be as concise as possible, and to put the subject in as clear and practical a light as is compatible with the faithful handling of its natural difficulties.

It is hoped that the work, in its present form, is adapted, not only for students, but for members of the profession who wish to refresh their anatomical knowledge.

Our best thanks are due to the Demonstrators of Anatomy at St. Bartholomew's Hospital for valuable suggestions.

65 GOWER STREET:
October 1879.

CONTENTS.

A MANUAL

OF THE

DISSECTION OF THE HUMAN BODY.

DISSECTION OF THE SCALP.

DISSECTION. AN INCISION should be made from the root of the nose along the mesial line of the vertex to the external protuberance of the occipital bone; another, horizontally round each half of the head, to join at right angles the two ends of the first incision. These incisions must not divide more than the skin, so that the subcutaneous vessels and nerves be not injured. It is well to dissect on one side of the head the muscles only, reserving the other side for the dissection of the vessels and nerves.

STRATA COMPOSING THE SCALP. The several strata of tissues covering the skull-cap are—1, the *skin*; 2, a thin layer of *adipose tissue* which contains the cutaneous vessels and nerves and the bulbs of the hair; and by which the skin is very closely connected to, 3, the *broad thin aponeurosis* of the occipito-frontalis muscle (aponeurosis of the scalp); 4, an abundance of loose *connective tissue*, which permits the free motion of the scalp upon, 5, the *pericranium*, or periosteum of the skull-cap.

Immediately beneath the skin, then, we expose the thin stratum of adipose tissue which connects it with the aponeurosis of the scalp. It forms a bed for the bulbs of the hair and for the ramifications of the cutaneous arteries. The toughness of this tissue,

in which the arteries ramify, does not permit them to retract when divided; hence the hæmorrhage which follows incised wounds of the scalp; hence, also, the difficulty of drawing them out with the forceps.

OCCIPITO-FRONTALIS MUSCLE AND EPICRANIAL APONEUROSIS. This cutaneous muscle is closely connected to the scalp. It consists of two fleshy portions, one on the occiput, the other on the forehead, connected by a broad aponeurosis. The occipital portion of the muscle takes origin from the outer two-thirds of the upper curved line of the occipital bone, and the adjoining part of the mastoid process. The fibres ascend over the back of the head, and terminate in the epicranial aponeurosis. The frontal portion, commencing in an arched form from the epicranial aponeurosis near the coronal suture, descends over the forehead, and terminates partly in the skin of the brow, partly in the orbicularis oculi and corrugator supercilii and in the internal angular process of the frontal bone. Some fibres run down the nose under the name of the *pyramidalis nasi*. The aponeurosis of the scalp is continued over the temples and side of the head, gradually changing from tendinous into connective tissue. This muscle enables us to move the scalp backwards and forwards. But its chief action is as a muscle of expression. It elevates the brows, and occasions the transverse wrinkles in the expression of surprise. It is supplied by the posterior auricular and temporal branches of the facial nerve.

MUSCLES OF THE EAR. There are several small muscles to move the cartilage of the ear. In man they are thin and pale; but in animals who possess a more delicate sense of hearing, they are much more developed, for the purpose of quickly directing the cartilage of the ear towards the direction of the sound.

M. ATTOLLENS AUREM. To indicate the position of this muscle the student should draw down the upper part of the pinna of the ear, when it will be found immediately under the ridge of skin so produced. It *arises* from the epicranial aponeurosis, and is *inserted* into the cranial aspect of the upper part of the concha.

M. ATTRAHENS AUREM. This muscle is smaller than the preceding, and its situation is indicated by the prominence

of skin produced by drawing backwards the front part of the helix. It *arises* from the aponeurosis of the occipito-frontalis, and is *inserted* into the front of the helix.

M. RETRAHENS AUREM. This muscle is exposed by reflecting the skin from the ridge produced by drawing the pinna forwards. It proceeds from the base of the mastoid process to the lower part of the concha. The retrahens and the attollens aurem are supplied by the posterior auricular branch of the facial nerve; the attrahens, by an offset from the temporal branch of the same nerve.

ARTERIES OF SCALP. The *arteries* of the scalp are derived, in front, from the *supra-orbital* and *frontal* arteries, branches of the ophthalmic artery which is a branch of the internal carotid; on the sides, from the *temporal*; behind, from the *occipital* and *posterior auricular*, all branches of the external carotid.

The *frontal* emerges from the orbit at its inner angle; it runs upwards for a short distance and inosculates with the following artery.

The *supra-orbital* passes through the supra-orbital notch and distributes branches, some of which ascend towards the top of the head and communicate with the temporal artery.

The *temporal*, about an inch and a half above the zygoma, divides into two branches—an anterior and a posterior. The *anterior* runs forwards in a tortuous course and anastomoses with the supra-orbital artery; the *posterior* (usually the larger) arches backwards over the ear, and its branches communicate with the corresponding branch of the opposite side and with the occipital and posterior auricular arteries.

The *posterior auricular* is a small vessel seen in the cleft between the ear and the mastoid process: it ascends, and divides into two branches: one, which passes backwards and inosculates with the occipital, the other, which runs forwards above the ear and communicates with the temporal artery.

The *occipital* may be noticed piercing the trapezius near to the external occipital protuberance; ascending over the back of the head, it divides into numerous branches which inosculate with the preceding arteries.

The veins of the scalp accompany their respective arteries.

NERVES OF THE SCALP. The sensory nerves of the scalp are supplied from each of the three divisions, namely the ophthalmic, the superior maxillary and inferior maxillary, of the fifth pair; also from the second cervical nerve. The nerves to the muscles of the scalp and ear come from the portio dura or seventh pair (fig. 1).

FIG. 1.

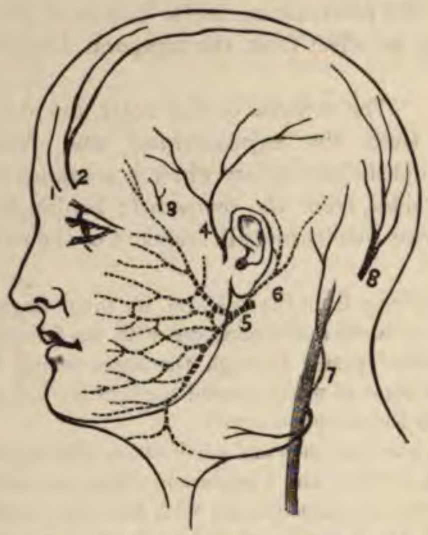


DIAGRAM OF THE NERVES OF THE SCALP.

1. Supra-trochlear.
2. Supra-orbital.
3. Temporal br. of the superior maxillary.
4. Auriculo-temporal br. of the inferior maxillary.
5. Facial represented by dotted lines.
6. Posterior auricular.
7. Small occipital.
8. Great occipital.

The *supra-trochlear nerve* is derived from the frontal branch of the ophthalmic division of the fifth. It appears at the inner angle of the orbit, and supplies the skin of the forehead, and the upper eyelid.

The *supra-orbital nerve* is a continuation of the frontal branch of the fifth. It emerges from the orbit through the notch in the frontal bone, and subdivides into branches, which are covered at first by the fibres of the orbicularis and occipito-frontalis; but they presently become subcutaneous, and terminate in two branches—an *inner*, which ascends, to

supply the structures as high as the parietal bone; and an *outer* and larger, which may be traced over the vertex as far as the occipital bone.

The *temporal branch* of the *superior maxillary nerve* pierces the temporal aponeurosis about an inch above the zygoma, and is distributed to the skin of the temple, communicating with the facial nerve and occasionally with the following.

The *auriculo-temporal nerve*, a branch of the inferior maxillary nerve, after sending a small filament to the upper part of the pinna, divides into two branches which accompany the divisions of the superficial temporal artery; of these the posterior is the smaller.

The *temporal branches* of the *facial nerve* lie superficial to the temporal aponeurosis, and supply the attrahens aurem, the orbicularis oculi, the occipito-frontalis, and the corrugator supercilii.

The *posterior auricular nerve* is a branch of the facial, and divides like its accompanying artery behind the pinna of the ear, into a *posterior* or *occipital* branch, which supplies the posterior belly of the occipito-frontalis, and into an *anterior* or *auricular* branch, which ends in the auricle, the retrahens aurem and the attollens aurem.

The *great occipital nerve* is the posterior branch of the second cervical nerve. After piercing the complexus it appears on the occiput with the occipital artery, and divides into wide-spreading branches which supply the skin. It communicates with the posterior auricular, the small occipital, and the third cervical nerves.

The *small occipital nerve*, a branch of the anterior division of the second cervical (p. 21), runs along the posterior border of the sterno-mastoid and supplies the scalp.

Occasionally, though rarely, a cutaneous branch of the suboccipital nerve is distributed to the back of the head.

POINTS OF SURGICAL INTEREST. Raise the aponeurosis of the scalp, and observe the quantity of loose connective tissue which intervenes between it and the pericranium. This tissue never contains fat. There are some points of surgical interest concerning it:—1. Its looseness accounts for the extensive effusions of blood which one often sees after injuries of the head. 2. It admits of large flaps of the scalp being detached from the skull-cap; but these flaps rarely slough, unless severely damaged, because they carry their blood-vessels with them. 3. In phlegmonous erysipelas of the scalp, the connective tissue becomes X.

infiltrated with pus and sloughs; hence the necessity of making incisions: for the scalp will not lose its vitality, and liberate the sloughs like the skin of other parts under similar conditions, because its vessels run above the diseased tissue, and therefore its supply of blood is not cut off.

LYMPHATICS OF THE SCALP. The lymphatics of the scalp run for the most part backwards towards the occiput; a few run towards the root of the zygoma, where they enter the lymphatic glands in those situations, respectively. Here, therefore, one finds glandular enlargements when the scalp is diseased.

DISSECTION. To examine the brain and its membranes, the skull-cap must be removed about half an inch above the supra-orbital ridges in front, and on a level with the occipital protuberance behind. It is better to saw only through the outer table of the skull, and to break through the inner with a chisel. In this way the dura mater and the brain are less likely to be injured. On removing the skull we expose a tough fibrous membrane, *the dura mater*, which forms the most external of the membranes of the brain.

The meningeal arteries ramify between the skull and the dura mater. We cannot, however, with the brain *in situ*, trace their course, at present, throughout; so their consideration must be deferred until the brain has been removed.

DURA MATER. This membrane is so called because it was thought to give rise to all the other fibrous membranes in the body. It is a dense white fibrous membrane, rough on its outer aspect, where it is more or less adherent to the inner surface of the skull, forming its internal periosteum. On its inner surface it is smooth and shining, being lined by the parietal layer of the arachnoid membrane, which most anatomists now describe as constituting a part of the dura mater. In consequence, the term '*subdural space*' is now substituted for the old one—'*the cavity of the arachnoid*.' The dura mater differs in its adhesion to the subjacent bones: its adhesion is firmest at the sutures, the petrous portion of the temporal bone, the basilar process, the body of the sphenoid, the cribriform plate of the ethmoid bone,

the depressions for the Pacchionian bodies, and at the margin of the foramen magnum. Its remarkably tough and fibrous structure adapts it exceedingly well to the four purposes which it serves:—1. It forms the internal periosteum of the skull. 2. It forms, for the support of the lobes of the brain, three partitions—namely, the falx cerebri, the falx cerebelli, and the tentorium cerebelli. 3. It forms the sinuses or venous canals which return the blood from the brain. 4. It forms sheaths for the nerves as they leave the skull.

Of the partitions formed by the dura mater for the support of the lobes of the brain, two are vertical, and separate, respectively, the two hemispheres of the cerebrum, and those of the cerebellum; the third slopes backwards, and supports the posterior lobes of the cerebrum.

FALX CEREBRI. This partition is named, from its resemblance to the blade of a sickle, *falx cerebri*. It is received into the longitudinal fissure, and separates the two cerebral hemispheres. It begins in a point attached to the *crista galli*, and gradually becomes broader as it extends backwards. Its upper edge is convex, and attached to the median groove on the inner aspect of the vertex of the skull; its lower margin is concave and free, and runs along the upper aspect of the corpus callosum. From its base or broadest part proceeds the sloping partition named *tentorium cerebelli*. This forms an arch for the support of the posterior lobes of the cerebrum, so that they may not press upon the cerebellum beneath. Observe that the tentorium is attached to the transverse ridge of the occipital bone, to the superior border of the petrous portion of the temporal bone, and to the posterior and anterior clinoid processes of the sphenoid. The small median partition which separates the lobes of the cerebellum is called the *falx cerebelli*. It is placed vertically in the same plane with the falx cerebri, and its point is downwards towards the foramen magnum.

TENTORIUM CEREBELLI.

FALX CEREBELLI.

The dura mater is supplied with nerves by the recurrent branch of the fourth nerve, by the fifth and eighth cranial nerves. Filaments have likewise been traced into it from the sympathetic system and from the Gasserian ganglion.

SINUSES OF THE DURA MATER.

It is one of the peculiarities of the cerebral circulation, that the blood is returned through canals or *sinuses* formed by the dura mater. These canals are produced by a splitting of the dura mater into two layers as shown in fig. 2, where 1 represents a vertical section through the superior longitudinal sinus. They are lined by the same smooth membrane as the rest of the venous system. Since their walls consist of unyielding structure, and are always on the stretch, it is obvious that they are admirably adapted to resist the pressure of the brain. There are fifteen of these sinuses; five are pairs, and five are single, as follows:

FIG. 2.

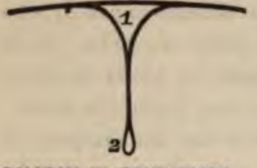


DIAGRAM TO SHOW FORMATION OF A SINUS.

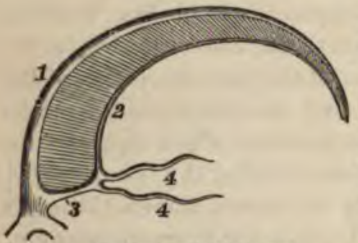
The five pairs of sinuses are—	The five single sinuses are—
The lateral.	The superior longitudinal.
The superior petrosal.	The inferior longitudinal.
The inferior petrosal.	The circular.
The cavernous.	The transverse.
The occipital.	The straight.

The blood from all these sinuses is eventually discharged through the internal jugular veins.

SUPERIOR LONGITUDINAL SINUS.

This runs along the upper edge of the falx cerebri (fig. 3). It begins very small at the crista galli, gradually increases in size in its course backwards, and opposite the internal protuberance of the occipital bone divides into the right and left lateral sinuses, the right being generally the larger. Besides numerous veins from the cancellous texture of the skull-cap, the superior longitudinal sinus receives large veins from each hemisphere of the cerebrum. It is interesting to observe that these veins run (as a rule) from behind forwards, contrary to the current

FIG. 3.



1. Superior longitudinal sinus.
2. Inferior longitudinal sinus.
3. Straight sinus.
4, 4. Venæ Galeni.

of blood in the sinus, and that they pass through the wall of the sinus very obliquely, like the ureter into the bladder. The probable object of this oblique entrance is to prevent regurgitation of blood from the sinus into the veins of the brain.

Cut open the superior longitudinal sinus: observe that it is triangular with its base upwards, and that its cavity is intersected in many places by slender fibrous cords, termed *chordæ Willisii.** Their precise use is not understood.

GLANDULÆ PACCHIONI. In the neighbourhood of the superior longitudinal sinus, we meet with small white elevated granulations, sometimes arranged singly, sometimes in clusters, which are received into the depressions on the inner aspect of the skull-cap. They are termed *glandulæ Pacchioni*,† and are found in four situations:—1. On the outside of the dura mater; often so large as to occasion depressions in the bones. 2. On the surface of the pia mater. 3. In the interior of the longitudinal sinus, covered by its lining membrane. 4. On the posterior and antero-inferior parts of the posterior lobe of the cerebrum.

They are due to an increased growth of the villi, which are normally found in the arachnoid membrane, and make their way, through the dura mater or the pia mater, to the different situations in which they are found. The greatest growth takes place from the visceral layer, as may be seen in the dissection of the brain. These bodies are not found at birth, but usually commence their growth about the third year, and are always found at the seventh year, after which they gradually increase as life advances.

The brain should now be removed, and preserved in spirit for future examination. Its anatomy, with that of its remaining membranes, will be described in a subsequent part of this work.

The other sinuses should now be examined.

LATERAL SINUSES. These are the two great sinuses through which all the blood from the brain is returned to the jugular veins. Their course is well marked in the dry skull. The

* So called after Willis, who first described them in his work, 'De Cerebri Anatome,' 1664.

† After the Italian anatomist who first described them, in 1705.

right is usually the larger. Each commences at the internal occipital protuberance, and proceeds at first horizontally outwards, enclosed between the layers of the tentorium, along a groove in the occipital bone and the posterior inferior angle of the parietal; it then descends along the mastoid portion of the temporal bone, and again indenting the occipital bone, turns forwards to the foramen lacerum posterius, and terminates in the internal jugular vein.*

INFERIOR LONGITUDINAL SINUS. This is of small size. It runs in the inferior free border of the falx cerebri, and terminates in the straight sinus at the anterior margin of the tentorium (fig. 3).

STRAIGHT SINUS. This may be considered as the continuation of the preceding. It runs along the line of junction of the falx cerebri with the tentorium cerebelli, and terminates at the divergence of the two lateral sinuses. It receives the two *venæ Galeni* (fig. 3), which return the blood from the lateral ventricles of the brain.

CAVERNOUS SINUS. This is so called because its interior is intersected by numerous cords. It extends along the side of the body of the sphenoid bone, outside the internal carotid artery. It receives the ophthalmic vein which leaves the orbit through the sphenoidal fissure; and it communicates with the circular sinus which surrounds the pituitary gland (fig. 4).

CIRCULAR SINUS. This surrounds the pituitary body (P in the diagram 4), and communicates on each side with the cavernous sinus.

PETROSAL SINUSES. These lead from the cavernous to the lateral sinuses. There are two on each side. The *superior* runs along the upper border of the pars petrosa, in the attached border of the tentorium cerebelli; the *inferior*, the larger of the two, runs along the suture between the pars petrosa and the occi-

* It has, in some subjects, another outlet, through the foramen mastoideum, or else through the posterior condyloid foramen.

pital bone, and ends in the lateral sinus just before this terminates in the internal jugular vein.

TRANSVERSE SINUS. This extends from one inferior petrosal to the other, across the basilar process of the occipital bone.

FIG. 4.

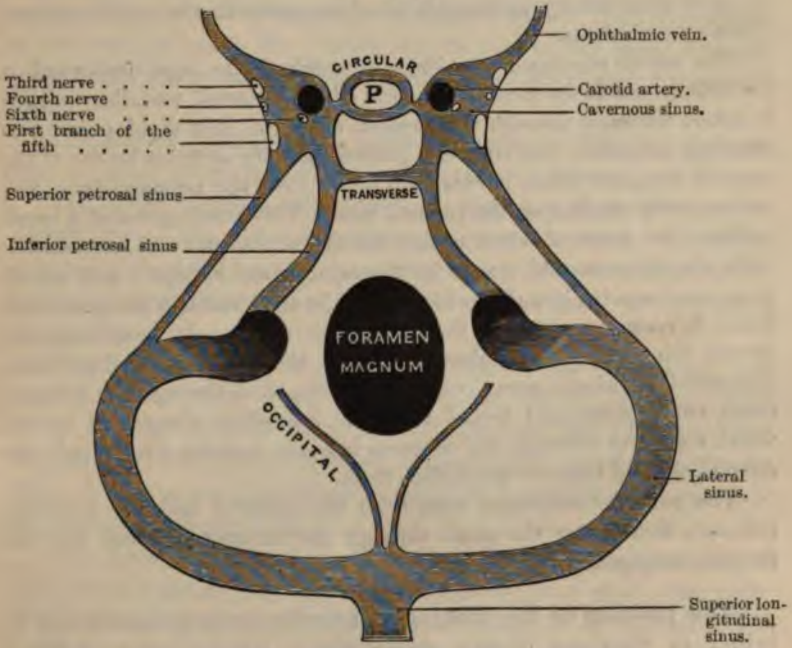


DIAGRAM OF THE VENOUS SINUSES AT THE BASE OF THE SKULL.

OCCIPITAL SINUSES. These are very small. They commence around the margin of the foramen magnum, run in the falx cerebelli, and open into the divergence of the lateral sinuses.*

* The junction of the several sinuses opposite the spine of the occipital bone is termed the *torcular Herophili*, after the celebrated anatomist who first described it. It is a kind of triangular reservoir, with the base below, and presents six openings—namely, that of the superior longitudinal sinus, those of the two lateral and of the two

MENINGEAL ARTERIES. These arteries ramify between the skull and the dura mater. Their course may be traced by the grooves which they make in the bones. They are termed *anterior*, *middle*, and *posterior*, from the fossæ in which they ramify.

The *anterior meningeal* are derived from the ethmoidal branches of the ophthalmic artery, and supply the dura mater in the neighbourhood of the ethmoid bone.

The *middle meningeal* are three in number: the most important is the *arteria meningea media*, a branch of the internal maxillary artery. It enters the skull through the foramen spinosum, and divides into two principal branches; one runs in a groove near the anterior border of the parietal bone, the other curves backwards over the temporal bone, and subsequently ramifies on the parietal bone. This artery gives off a small branch—the *petrosal*, which enters the hiatus Fallopii and anastomoses with the stylo-mastoid artery in the aquæductus Fallopii; and one or more anastomosing branches which enter the orbit through the sphenoidal fissure to communicate with the ophthalmic artery. It is accompanied by two veins which empty themselves into the internal maxillary vein. The *arteria meningea parva*, which enters the skull through the foramen ovale, and a *meningeal branch* from the ascending pharyngeal artery, which comes up through the foramen lacerum medium, also supply the dura mater and bones of the middle fossa.

The *posterior meningeal* come from the occipital and the vertebral arteries; these enter the skull through the foramen jugulare and the foramen magnum, respectively.

The position of the meningeal arteries renders them liable to injury in fractures of the skull; hence extravasation of blood between the skull and dura mater is one of the common causes of compression of the brain.

DISSECTION. The student should now examine the cranial nerves as they pass out through the foramina in the base of the skull, and then dissect the cavernous sinus.

EXIT OF THE CRANIAL NERVES. The cranial nerves proceed in pairs through the foramina at the base of the skull; they are named

occipital, and that of the straight sinus. The term *torcular* is an incorrect version of the original word σωλὴν (a canal or gutter), employed by Herophilus.

first, second, third, fourth, &c., pairs, according to the order of succession from before backwards.

The *first* is the *olfactory nerve.* This cannot be seen, because the olfactory bulb has been removed with the brain. From the bulb proceed about twenty branches, which pass through the foramina in the cribriform plate of the ethmoid bone, and are arranged in three sets—inner, middle, and outer. The *inner* pass to the septum nasi; the *middle* to the roof of the nose; and the *outer* to the outer wall of the nose as low as the middle turbinated bone.

The *second* (*optic nerve*) passes through the foramen opticum into the orbit accompanied by the ophthalmic artery.

The *third* (*motor oculi*) passes through the dura mater, close behind the anterior clinoid process, traverses the outer wall of the cavernous sinus, and enters the orbit through the sphenoidal fissure. Before passing through the fissure, it divides into two branches, an upper and a lower.

The *fourth* (*patheticus*), a small nerve, passes through the dura mater a little behind the posterior clinoid process. Like the preceding nerve, it passes through the outer wall of the cavernous sinus, and then runs forward through the sphenoidal fissure. Here, it lies above the third nerve, and is finally distributed to the superior oblique muscle.

The *fifth* (*trifacial nerve*) passes through an aperture in the dura mater beneath the tentorium cerebelli, just above the point of the petrous portion of the temporal bone. It is formed of two parts—a larger or sensory root, and a smaller or motor. Upon its larger or sensory root is developed a large ganglion, the *Gasserian ganglion.* From this ganglion proceed the three primary divisions of the nerve—the *ophthalmic*, which passes through the outer wall of the cavernous sinus, and subsequently enters the orbit through the sphenoidal fissure;* the *superior maxillary*,

* While the nerve is in the cavernous sinus it receives filaments of communication from the cavernous plexus, and also sends back a branch to supply the tentorium cerebelli (Arnold). The ophthalmic nerve is frequently very intimately connected with a branch from the fourth nerve.

which passes through the foramen rotundum; and the *inferior maxillary*, which passes through the foramen ovale. The smaller root of the fifth lies beneath the ganglion, with which it has no

Fig. 5.

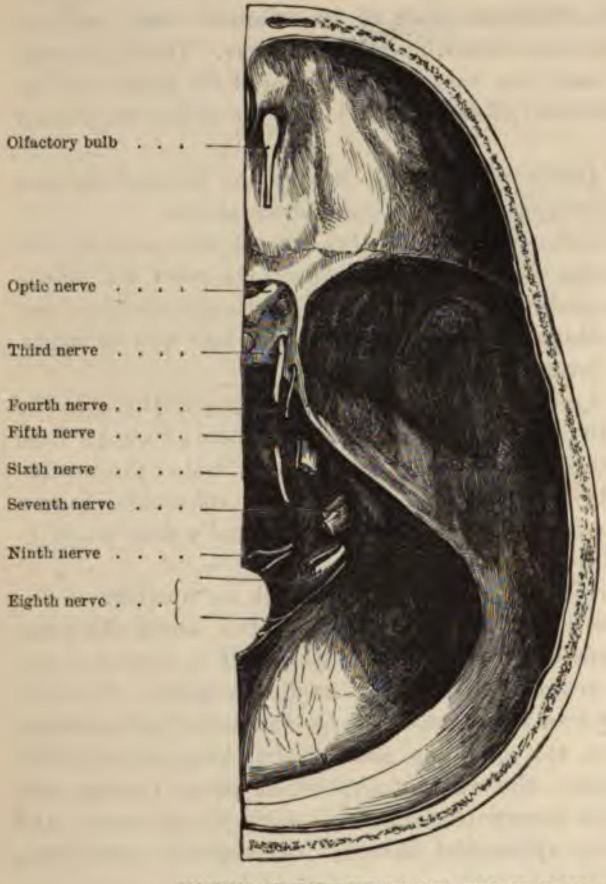


DIAGRAM OF THE EXIT OF THE CRANIAL NERVES.

communication, and then joins the inferior maxillary division to supply the muscles of mastication with motor power.

The *sixth* (*abducens*) pierces the dura mater behind the body of the sphenoid bone, which it grooves. It then passes along the inner wall of the cavernous sinus, external to the carotid artery, and enters the orbit through the sphenoidal fissure, to supply the external rectus. It is connected with the cavernous plexus as it passes along the inner wall of the sinus.

The *seventh*, consisting of the *facial* and *auditory nerves*, passes (with the auditory artery) through the meatus auditorius internus, where the two are connected with each other by small offsets. At first the facial nerve lies internal to and above the auditory; but at the bottom of the auditory meatus, the facial nerve leaves it to traverse a tortuous bony canal, the 'aquæductus Fallopii;' the auditory being distributed to the internal ear.

The *eighth*, consisting of the *glosso-pharyngeal*, *pneumo-gastric* and *spinal accessory* nerves, passes through the anterior part of the foramen lacerum posterius. These three divisions do not all pass through the same tube of the dura mater. The glosso-pharyngeal has a separate tube, anterior to the other two, which have a common one.

The *ninth*, or *hypoglossal nerve*, passes through the anterior condyloid foramen in two fasciculi, which unite external to the skull.

DISSECTION. We must now examine the cavernous sinus, and the nerves which course along its walls to the orbit—namely, the third, the fourth, the ophthalmic division of the fifth and the sixth nerves.

CAVERNOUS SINUS. This sinus (fig. 4) lies by the side of the body of the sphenoid bone. In front it receives the ophthalmic vein, which passes backwards through the sphenoidal fissure; while posteriorly it divides into the superior and inferior petrosal sinuses, which have been already described; on the inner side it communicates with the circular sinus, which surrounds the pituitary body (P in the diagram 4). The interior of the sinus is remarkable for the numerous fine bands of tissue which interlace in all directions.

In the outer wall of the cavernous sinus we trace, from above

downwards, the third nerve, the fourth, and the ophthalmic division of the fifth, in their course to the orbit. On its inner wall, are situated the internal carotid artery with the sixth nerve below and to its outer side. These structures are not actually within the sinus so as to be bathed by the blood, for they are separated from it by the lining membrane of the sinus.

Relative Positions of Nerves in Sphenoidal Fissure.

These nerves should be traced from the cavernous sinus, forwards, so as to see how they alter their relative positions before entering the sphenoidal fissure, and, again, in their passage through it.

Just *before entering the sphenoidal fissure*, the fourth nerve (on its way to the orbital surface of the superior oblique) gets above the third, which here divides into an upper and a lower branch (both proceeding to the ocular surface of the muscles they supply); lower still, we have the frontal, lacrymal, and nasal divisions of the ophthalmic; lowest of all is the sixth nerve on its way to the external rectus.

In their passage through the sphenoidal fissure, we find that the fourth nerve, the frontal and lacrymal branches of the ophthalmic, lie at the top, on the same level, and in the above order from within outwards: thus they enter the orbit above the muscles. Lower, and in the following order from above downwards, come the upper division of the third, the nasal branch of the ophthalmic, the lower division of the third, and the sixth; all of which (with the ophthalmic vein) enter the orbit between the two origins of the rectus externus.

The dissector will better remember the varying relations of these nerves, when he has learnt their respective destinations.

Curves of the Carotid Artery.

After the removal of the cavernous sinus, a good view is obtained of the curves, like the letter S, made by the carotid artery on the side of the pituitary fossa. The vessel enters the cranium at the apex of the petrous portion of the temporal bone, makes its sigmoid curves, and then passes through the dura mater, between the anterior clinoid process and the optic nerve, where it gives off the ophthalmic artery. Within the cavernous sinus, small branches, *arteriæ receptaculi*, arise from the carotid and supply the pituitary body, and the walls of the sinus.

A careful dissection would show a plexus of sympathetic nerves

on the carotid artery, as it lies by the side of the body of the sphenoid. This is the CAROTID PLEXUS. It is connected by numerous filaments with the sixth nerve and the Gasserian ganglion. Those filaments of the sympathetic seen on the artery in the upper part of the cavernous sinus, constitute the CAVERNOUS PLEXUS, which is in communication with the third, the fourth, and the ophthalmic division of the fifth nerves.

THE DISSECTION OF THE NECK.

DISSECTION. Make a vertical incision through the skin, down the middle of the neck from the symphysis of the lower jaw to the sternum; a second along the clavicle to the acromion; a third along the base of the jaw as far as the mastoid process. Reflect the skin, and expose the cutaneous muscle called the *platysma myoides.* Between the platysma and the skin is a layer of adipose tissue, called the *superficial fascia.* It varies in thickness in different subjects, but is generally more abundant at the upper part of the neck, especially in corpulent individuals, in whom it occasions a double chin.

PLATYSMA MYOIDES. The *platysma myoides* is the thin cutaneous muscle of the neck. It arises from the subcutaneous tissue over the pectoralis major and deltoid muscles;* thence proceeding obliquely over the clavicle and the side of the neck, its fibres become more closely aggregated, and terminate thus:—The anterior cross those of the opposite platysma, immediately below the symphysis of the jaw, and are lost in the skin of the chin; the middle are attached along the base of the jaw; the posterior cross the masseter muscle, and terminate, partly in the subcutaneous tissue of the cheek, partly in the muscles at the corner of the mouth.†

* Some anatomists describe it as having a slender origin from the clavicle and the acromion.

† Some of the uppermost fibres of this part of the platysma take the name of *musculus risorius*: this will be described among the muscles of the face.

The platysma forms a strong muscular defence for the neck. It is also a muscle of expression.* It is supplied with nerves by the cervical plexus, and by the cervical branch of the facial nerve.

DISSECTION. Cut through the platysma near the clavicle and turn it upwards. Beneath it lies the general investment of the neck, called the *deep cervical fascia*. Upon this fascia we trace the superficial branches of the cervical plexus of nerves, the external jugular vein, and a smaller vein in front, called the anterior jugular. These superficial veins are so variable in size and course, that a general description only is applicable.

EXTERNAL JUGULAR VEIN. The *external jugular vein* is formed within the substance of the parotid gland by the junction of the temporal and internal maxillary veins. After receiving the transverse facial and posterior auricular veins, it appears at the lower border of the gland, crosses obliquely over the sterno-mastoid muscle (fig. 6), to its posterior border, nearly as low down as the clavicle, where it passes through the deep cervical fascia and terminates in the subclavian vein. It is usually provided with two pairs of valves. A line drawn from the angle of the jaw to the middle of the clavicle would indicate its course. To trace the vein, during life, press upon it just above the clavicle; but do not be surprised if you fail to find it; it is sometimes wanting, and frequently is very small.

* If the entire muscle be permanently contracted it may occasion wry-neck, though distortion from such a cause is an exceedingly rare occurrence. A case in point is related by Mr. Gooch (*Chirurg. Works*), in which a complete cure was effected, after the failure of all ordinary means of relief, by the division of the platysma a little below the jaw.

The platysma myoides belongs to a class of muscles called *cutaneous*, from their office of moving the skin. There are not many in man, except upon the neck and face, and there is a little one (*palmaris brevis*) in the palm of the hand. To understand their use thoroughly we must refer to the lower orders of animals, in whom they fulfil very important functions, by moving not only the skin, but also its appendages. For instance, by muscles of this kind the hedgehog, porcupine, and animals of that family can roll themselves up and erect their quills: we are all familiar with the broad '*panniculus carnosus*' on the sides of herbivorous quadrupeds, which enables them to twitch their skins, and thus rid themselves of insects. In birds, too, these cutaneous muscles are extremely numerous, each feather having appropriate muscles to move it.

Near the angle of the jaw the external jugular vein communicates by a large branch with the internal jugular.

Before its termination the external jugular vein generally receives the supra-scapular, posterior scapular, and other unnamed veins: a disposition very unfavourable for the surgeon, because there is a *confluence of veins immediately over the subclavian artery* in the place where it is usually tied.

Fig. 6.

DIAGRAM OF THE SUPERFICIAL NERVES AND VEINS OF THE NECK.

ANTERIOR JUGULAR VEIN. The *anterior jugular vein* is situated more in the middle of the neck, and is much smaller than the external jugular. It commences by small branches below the chin, and runs down the front of the neck, nearly to the sternum: it then curves outwards, beneath the sterno-mastoid muscle, and opens either into the external jugular or the subclavian vein. We commonly meet with two anterior jugular veins, one on either side; immediately above the sternum they communicate by a transverse branch.

The size of the anterior jugular vein is inversely proportionate to that of the external jugular. When the external jugular is small, or terminates in the internal jugular, then the anterior jugular becomes an important supplemental vein, and attains considerable size. It is not uncommon to find it a quarter of an inch in diameter, and we have seen it nearly half an inch. These varieties should be remembered in tracheotomy.

Superficial lymphatic glands are sometimes found near the cutaneous veins of the neck. They are small, and escape observation unless enlarged by disease. One or two are situated over the sterno-mastoid muscle; others, near the mesial line.

CUTANEOUS NERVES OF THE NECK.

The cutaneous nerves of the neck are the superficial branches of the cervical plexus: the plexus itself cannot at present be seen. It lies under the sterno-mastoid muscle, close to the transverse processes of the four upper cervical vertebræ, and is formed by the communications of the anterior divisions of the four upper cervical nerves. The cutaneous branches of the plexus emerge from beneath the posterior border of the sterno-mastoid, and take different directions. They are named thus (fig. 6):

Cutaneous branches of the cervical plexus.	Ascending branches	Auriculo-parotidean. Small occipital.
	Transverse branch	Superficial cervical.
	Descending branches . . .	Sternal. Clavicular. Acromial.

The *auriculo-parotidean n.* comes from the second and third cervical nerves, and ascends obliquely over the sterno-mastoid muscle, near the external jugular vein, towards the parotid gland. Near the gland it divides into two principal branches, of which the *anterior* or facial branch is distributed to the skin over the parotid gland, and the side of the cheek; the *posterior*, after ascending a short distance, gives off an *auricular* branch, which ramifies mainly upon the cranial aspect of the cartilage of the ear; and a smaller branch, the *mastoid*, which supplies the skin over the mastoid process. Other filaments of this nerve communicate in the substance of the parotid gland with branches of the facial nerve.

The *small occipital n.* comes from the second cervical nerve. It runs near the posterior border of the sterno-mastoid muscle to the occiput, where it supplies the back of the scalp, and communicates with the great occipital and the posterior auricular nerves. It also sends off a branch, which is distributed to the skin of the temporal region. Beneath the sterno-mastoid this nerve commonly forms a loop, which embraces the nervus accessorius, and sends a branch to it.

The *transverse* branch, called the *superficial cervical n.*, comes from the second and third cervical nerves. It passes forwards over the sterno-mastoid muscle, and supplies the front of the neck. Some of its filaments ascend towards the jaw, and join the cervical branch of the facial nerve; other filaments descend and supply the skin in front of the neck as low as the sternum.

The *descending* branches are derived from the third and fourth cervical nerves, and divide into three branches, which cross over the clavicle, and supply the skin of the front of the chest and shoulder. Of these, one, called the *sternal*, supplies the skin over the upper part of the sternum; another, the *clavicular*, passes over the middle of the clavicle, and is distributed to the skin over the pectoral muscle, the mammary gland, and the nipple; the third, named *acromial*, crosses over the acromion to supply the skin of the shoulder.

Reviewing these cutaneous branches of the cervical plexus, we find that they have a very wide distribution, for they supply the skin covering the following parts—viz., the ear, the back of the scalp, the side of the cheek, the parotid gland, the front and side of the neck, the upper and front part of the chest and shoulder.

CERVICAL BRANCH OF THE FACIAL NERVE. Look for this branch beneath the fascia near the angle of the jaw (p. 92). It leaves the parotid gland, and divides into filaments which curve forwards below the jaw; some of these join the transverse branch of the cervical plexus; others supply the platysma.

DEEP CERVICAL FASCIA. Now turn your attention to the membranous investment called the *deep cervical fascia*, which encloses the several structures of the neck. In some subjects the fascia is very thin; in others, with strong muscles, it is proportionally dense and resisting. It is always stronger in particular situations, for the more effective protection of the parts

beneath; for instance, in front of the trachea, in the fossa above the clavicle, and below the angle of the jaw. It not only covers the soft parts of the neck collectively, but, by its inflections, forms separate sheaths for the muscles, vessels, and glands. It isolates them, and keeps them in their proper relative position. A lengthened description of its numerous layers would be not only extremely tedious, but unintelligible, without considerable knowledge of the anatomy of the neck. We propose, therefore, to give only a general outline of the fascia, and of its principal layers, commencing from behind.

Tracing it from behind, we find that the cervical fascia (sometimes called *deep cervical* or *muscular fascia* of the neck) is attached to the ligamentum nuchæ and to the spinous and transverse processes of the cervical vertebræ. From these attachments it passes forwards over the posterior triangle of the neck to the posterior border of the sterno-mastoid, where it splits into two layers, which invest that muscle and reunite at its anterior border. It then passes towards the mesial line, where it becomes continuous with the corresponding fascia of the opposite side. The layer which lies in front of the sterno-mastoid is attached above to the base of the inferior maxilla, and passes over the parotid gland, to the zygoma, to the mastoid process, and the superior curved line of the occipital bone. Traced downwards, we find it attached to the clavicle and to the upper border of the sternum. In the middle line it is closely connected to the hyoid bone, and below the thyroid body divides into two layers, one being attached to the front of the upper border of the sternum, the other to the back of the upper border of the same bone. Between these layers there is a well-marked interval, containing more or less fat, and one or two small lymphatic glands. This layer forms investing sheaths for the depressor muscles of the os hyoides and larynx.

The other layer—viz., that which passes beneath the sterno-mastoid—forms the common sheath for the carotid artery, internal jugular vein, and the pneumogastric nerve, which lie behind this muscle; it is continued behind the pharynx (constituting the *prævertebral fascia*) to join the fascia of the opposite side.

Below, it is attached to the first rib, to which it binds down the intermediate tendon of the omo-hyoid; and still further down it is continuous in the chest with the pericardium. It may, also, be traced under the clavicle along the axillary vessels and nerves into the axilla. Above, it is attached to the angle of the lower jaw, from which it extends backwards to the styloid process, and forms the *stylo-maxillary* ligament. Thence it is attached to the base of the skull, the petrous portion of the temporal bone, and the basilar process of the occipital bone.

A correct knowledge of the attachments of the principal layers of the cervical fascia is essential to a right understanding of the course which pus takes when it forms in the neck. For instance, suppose the pus to be formed at the lower part of the neck. If it be seated immediately under the superficial layer (which is attached to the clavicle), it may burrow beneath the clavicle into the axilla. But if it be seated beneath the deep layer (which is attached to the first rib), then it becomes a more serious affair, since the pus may travel through the loose tissue by the side of the pharynx, and make its way into the chest, where it may burrow down the anterior or the posterior mediastinum, and burst into the trachea or the œsophagus.

Besides forming sheaths for the several structures of the neck, there are other purposes to which the cervical fascia is subservient. The firm attachment of its layers to the sternum, the first rib, and the clavicle, forms a fibrous barrier at the upper opening of the chest, which supports the soft parts, and prevents their yielding to the pressure of the atmosphere during inspiration. Dr. Allan Burns [*] first pointed out this important function of the cervical fascia, and has recorded a case exemplifying the results of its destruction by disease.

Moreover, the great veins at the root of the neck, namely, the internal jugular, subclavian, and innominate, are so closely united by the cervical fascia to the adjacent bones and muscles, that

* 'Surgical Anatomy of the Head and Neck.'

when divided they gape. They are, as the French express it, '*canalisées*,' and are therefore better able to resist the pressure of the atmosphere, which tends to render them flaccid and impervious during inspiration. But this anatomical disposition of the great veins makes them more liable to the entrance of air when wounded. Instances of death have been recorded, resulting from the sudden entrance of air into the veins during operations about the neck, or even the axilla.

STERNO-CLEIDO-MASTOIDEUS. The sterno-cleido-mastoideus *arises* by a rounded tendon from the upper part of the sternum, and by fleshy fibres, from the sternal third of the clavicle. It is *inserted* by a thick tendon into the mastoid process, and by a thin aponeurosis into about the outer half of the superior curved ridge of the occipital bone.

The sternal origin of the muscle is at first separated from the clavicular by a slight interval: subsequently the sternal fibres gradually overlap the clavicular. The muscle is confined by its strong sheath of fascia, in such a manner that it forms a slight curve, with the convexity forwards. Observe especially that its front border overlaps the common carotid artery; along this border we make the incision in the operation of tying the vessel.

ACTION OF STERNO-MASTOID. When both sterno-mastoids act simultaneously they draw the head and neck forwards, and are therefore especially concerned in raising the head from the recumbent position. When one sterno-mastoid acts singly, it turns the head obliquely towards the opposite shoulder; in this action it co-operates with the splenius of the other side.* On emergency, the sterno-mastoid acts as a muscle of inspiration, by raising the sternum; its fixed point being, in this case, at the head.

The sterno-mastoid is supplied by three nutrient arteries—an

* The single action of the muscle is well seen when it becomes rigid and causes a wry neck. Other means of relief failing, the division of the muscle near its origin is sometimes beneficial in curing the distortion. In deciding as to the propriety of this operation, we should be careful to examine the condition of the other muscles, lest, after having divided the sterno-mastoid, we should be disappointed in removing the deformity.

upper, a middle, and a lower. The upper sterno-mastoid artery, a branch of the occipital, enters the muscle with the n. accessorius, close to the mastoid process of the temporal bone; the middle mastoid is a branch of the superior thyroid, and enters the under surface of the muscle, crossing over the common carotid on a level with the thyroid cartilage; the lower mastoid is a branch of the supra-scapular, and supplies the clavicular portion of the muscle, close to its origin.

The sterno-mastoid is supplied with nerves by the n. accessorius, and by branches from the deep cervical plexus; these branches come from the second and sometimes the third cervical nerves.

TRIANGLES OF THE NECK. Anatomists avail themselves of the oblique direction of the sterno-mastoid muscle to divide the neck on each side into two great triangles, an anterior and a posterior (fig. 7). The base of the anterior triangle is formed by the jaw, its sides by the mesial line and the front border of the sterno-mastoid. The posterior has the clavicle for the base, while the sides are defined by the hind border of the sterno-mastoid, and the front border of the trapezius.

The omo-hyoid muscle, which crosses the neck under the sterno-mastoid, subdivides these primary triangles into four smaller ones (fig. 7), of unequal size: an anterior superior, an anterior inferior, a posterior superior, and a posterior inferior. The direction of the omo-hyoid muscle renders their boundaries at once obvious.

CONTENTS OF POSTERIOR TRIANGLE. The fat and connective tissue must now be carefully removed from the posterior triangle. The following muscles will be seen forming its floor, viz.; beginning from above, the splenius capitis, the levator anguli scapulæ, the scalenus medius and posticus, and a small portion of the serratus magnus. This triangle is subdivided into two unequal parts by the posterior belly of the omo-hyoid—an upper or *occipital* and a lower or *clavicular*. In the occipital triangle, besides the muscles just mentioned (with the exception of the serratus magnus), are found the superficial branches of the cervical plexus,

and, passing obliquely downwards from beneath the sterno-mastoid is the spinal accessory nerve, which enters the under part of the trapezius. The transversalis colli (posterior scapular) artery and vein, and its branch the superficialis colli (which chiefly supplies the trapezius), cross transversely outwards the lower part of the space. A chain of lymphatic glands is also found along the posterior border of the sterno-mastoid.

FIG. 7.

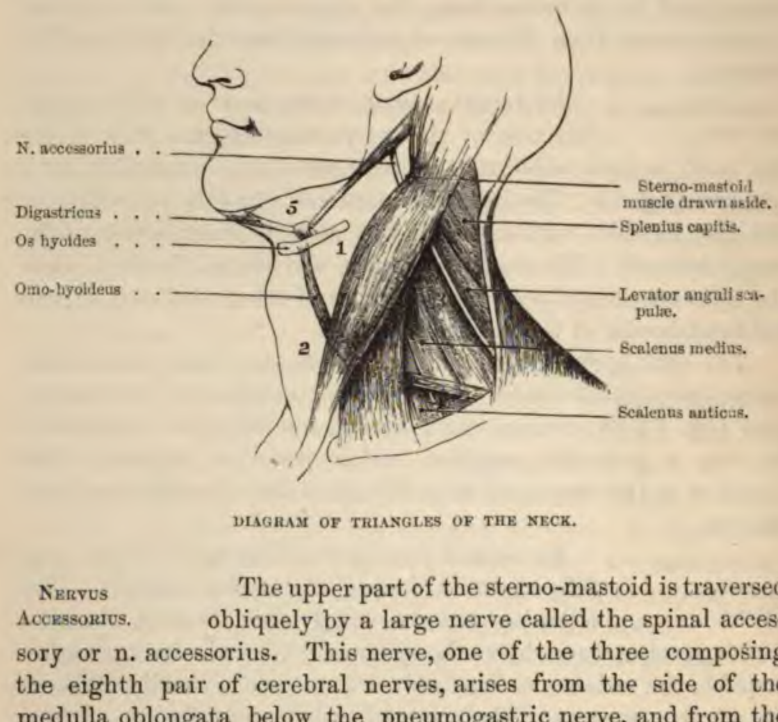


DIAGRAM OF TRIANGLES OF THE NECK.

NERVUS ACCESSORIUS. The upper part of the sterno-mastoid is traversed obliquely by a large nerve called the spinal accessory or n. accessorius. This nerve, one of the three composing the eighth pair of cerebral nerves, arises from the side of the medulla oblongata below the pneumogastric nerve, and from the cervical portion of the spinal cord by a series of filaments from the lateral tract as low down as the sixth cervical vertebra. It ascends between the ligamentum denticulatum and the posterior roots of the spinal nerves, through the foramen magnum into the skull.

It consists of two portions, a *medullary* and a *spinal*, and leaves the skull through the foramen jugulare. Here the *medullary* or *accessory* portion is connected with the ganglion of the root of the pneumogastric by several filaments; and lower down it again joins the pneumogastric at the ganglion of the trunk, below which the two nerves become blended. The medullary and spinal portions communicate in the foramen jugulare. Below the foramen the *spinal* part runs behind the internal jugular vein, then pierces obliquely the upper third of the sterno-mastoid, and crosses the posterior triangle of the neck to the under surface of the trapezius, to which it is distributed. The nervus accessorius supplies also the sterno-mastoid, and, after leaving the muscle, is joined by branches from the second and third cervical nerves. Beneath the trapezius it forms a plexus with the third and fourth cervical nerves. The upper mastoid artery, a branch of the occipital, enters the sterno-mastoid with the nerve.

SUPRA-CLAVICULAR TRIANGLE. The *supra-clavicular triangle* is bounded below by the clavicle, in front by the outer border of the sterno-mastoid, and above by the posterior portion of the omo-hyoid muscle. The area of the triangle thus formed will vary in proportion to the obliquity of the omo-hyoid muscle, and the extent to which the sterno-mastoid and trapezius are attached to the clavicle. The depth of the vessels and nerves contained in this space depends, not only upon the degree to which the clavicle arches forwards, but varies with the elevation and depression of the shoulder.

Immediately beneath the skin covering this region we find the platysma myoides, the descending branches of the cervical plexus, and a layer of fascia which binds down the omo-hyoid muscle to the clavicle. Beneath this is a deeper layer of fascia, which covers the subclavian vessels and the brachial plexus of nerves, and descends with them beneath the clavicle into the axilla. Between these two layers we meet with more or less fat and areolar tissue, and lymphatic glands continuous with those in the axilla. It will be easily understood how a collection of pus, originating in the axilla, may ascend in front of the vessels and point above the

clavicle, or, *vice versâ*, how matter formed in the neck may travel under the clavicle and point in the axilla.

Near the posterior border of the sterno-mastoid muscle the external jugular vein passes through both layers of the fascia, and terminates in the subclavian; but before its termination it is commonly joined by the supra-scapular, the posterior scapular, and other unnamed veins proceeding from the surrounding muscles; so that there is in this situation a *confluence of veins*, which, when large or distended, are exceedingly embarrassing.

Dissection. The fascia and the glands should be removed, and the following objects carefully dissected. Behind and nearly parallel with the clavicle is the supra-scapular (transversalis humeri) artery, a branch of the thyroid axis. A little higher is the transversalis colli, or posterior scapular (commonly a branch of the thyroid axis), which crosses the lower part of the neck towards the posterior superior angle of the scapula. Both these arteries, *the last particularly*, are very irregular in respect to their origin. Search for the outer border of the scalenus anticus, which descends from the transverse processes of the cervical vertebræ to the first rib: running down longitudinally upon it is seen the phrenic nerve. The subclavian vein lies upon the first rib in front of the insertion of the anterior scalene muscle. The subclavian artery, which appears a little higher than the vein behind the outer border of the scalenus anticus, must be fairly exposed, care being taken to preserve the small branch which proceeds from the brachial plexus to the subclavius muscle. The large nerves constituting the brachial plexus will be found emerging between the scalenus anticus and medius, higher than the subclavian artery, and on a plane posterior to that vessel.

Dissection of the Anterior Triangle. The *anterior triangle* must now be dissected. In doing so, notice, before the deep cervical fascia is removed, the arching forwards of the anterior border of the sterno-mastoid muscle, which is connected to the lower jaw by the fascia, so that the common carotid artery is concealed from view before the parts are disturbed. Then examine the flat muscles in front of the neck, which pull down the larynx and

os hyoides; namely, the sterno-hyoid, sterno-thyroid, omo-hyoid, and thyro-hyoid.* Remove the fascia which covers them, disturbing them as little as possible, and take care of the nerves (branches of the descendens noni), which enter their outer borders.

STERNO-HYOID. The sterno-hyoid *arises* from the back part of the sternum and posterior sterno-clavicular ligament, and occasionally from the clavicle and cartilage of the first rib, and is *inserted* into the lower border of the body of the os hyoides. This is the most superficial of the muscles in front of the neck. We cut in the mesial line between these muscles in laryngotomy.

STERNO-THYROID. The sterno-thyroid *arises* from the back part of the sternum, below and internal to the origin of the sterno-hyoid, and the cartilage of the first rib, and is *inserted* into the oblique ridge on the ala of the thyroid cartilage. This muscle is situated immediately under, and is much broader than, the sterno-hyoid.

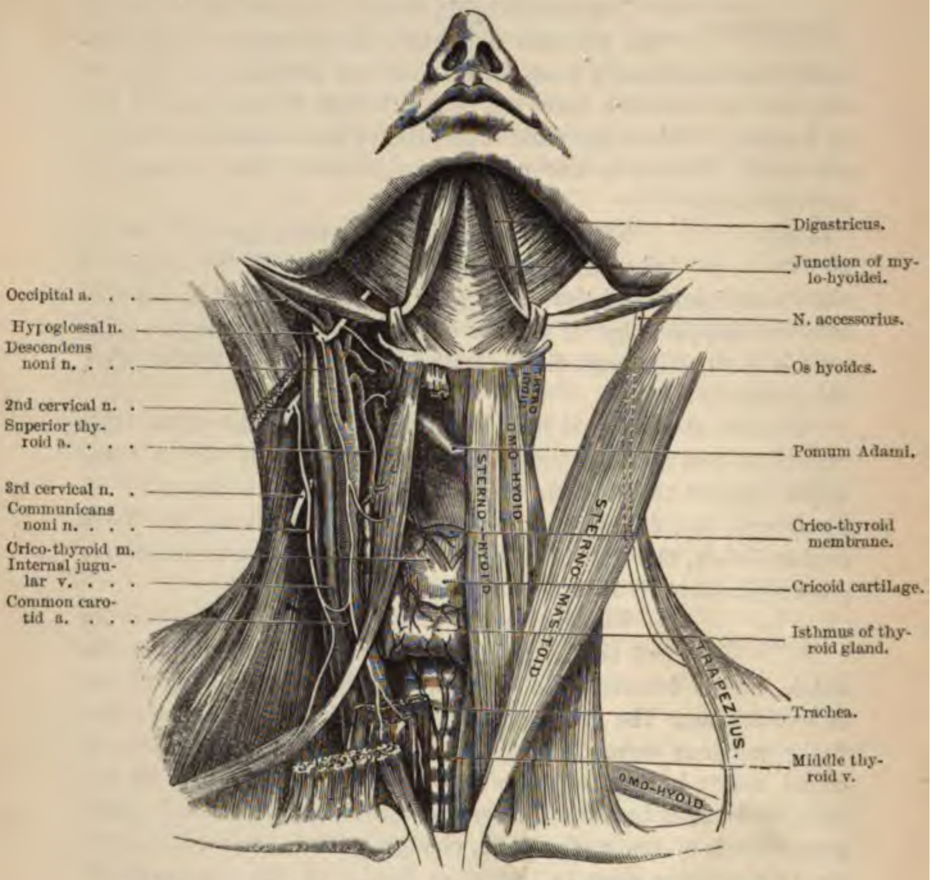
The two sterno-hyoid muscles converge as they ascend to their insertions, and opposite the cricoid cartilage and the two or three upper rings of the trachea they are in contact with one another. The sterno-thyroid, however, diverge to their insertions, but are in contact below, the result of which is that the trachea is completely covered in front by muscular fibres.

OMO-HYOID. The omo-hyoid *arises* from the upper border of the scapula, and from the ligament over the notch, and is *inserted* into the lower border of the body of the os hyoides near the great cornu. This muscle consists of two fleshy portions connected by a tendon. From the scapula it comes nearly horizontally forwards across the lower part of the neck, and passes beneath the sterno-mastoid, *over* the sheath of the great vessels of the neck; then, changing its direction, it ascends nearly vertically close to the outer border of the sterno-hyoid.

* The sterno-hyoid and sterno-thyroid muscles often present slight transverse tendinous lines. These tendinous intersections are quite rudimentary in man; but in some animals with long necks, e.g. the giraffe, they are so developed that each depressor muscle is composed of alternations of muscle and tendon.

Thus the muscle does not proceed straight from origin to insertion, but forms an obtuse angle beneath the sterno-mastoid muscle. The intermediate tendon is situated at the angle, and is bound

Fig. 8.



CENTRAL LINE OF NECK.—COURSE AND RELATIONS OF COMMON CAROTID ARTERY.

down to the first rib and the sternum by a process of the deep cervical fascia. The object of this peculiar direction of the omo-hyoid appears to be to keep tense that part of the cervical fascia

which covers the apex of the lung, and thus to resist atmospheric pressure.

ACTION OF THE DEPRESSOR MUSCLES. The sterno-hyoid, sterno-thyroid, and omo-hyoid muscles, co-operate in fixing the larynx and os hyoides, e.g. in sucking, or they depress the larynx after it has been raised in deglutition. Again, they depress it in the utterance of low notes. That the larynx is raised or depressed according to the height of the note may be ascertained by placing the finger upon it while singing through an octave.

These depressor muscles are all supplied with nerves (fig. 8, p. 30) by the *descendens noni* (a branch of the ninth or hypoglossal), and by the *communicantes noni* (branches of the second and third cervical nerves). The descendens noni sends a separate branch to each belly of the omo-hyoid. They are supplied with blood by the superior and inferior thyroid arteries.

THYRO-HYOID. The thyro-hyoid *arises* from the oblique line on the ala of the thyroid cartilage, and runs up to be *inserted* into the body and half the great cornu of the os hyoides. This muscle is a continuation of the sterno-thyroid. It is supplied by a special branch from the hypoglossal nerve. It covers the thyro-hyoid membrane and the superior laryngeal nerve and artery, as they enter the larynx.

DISSECTION. The sterno-mastoid muscle must now be cut transversely through the middle, and the two ends turned upwards and downwards, so that they may be replaced if necessary. This done, notice the strong layer of fascia which lies under the muscle and forms part of its sheath. It is attached to the angle of the jaw, thence descends over the large vessels of the neck, and is firmly connected to the clavicle and first rib. This fascia prevents matter coming to the surface, when suppuration takes place by the side of the pharynx.

Remove the fascia, and clean the various structures beneath the sterno-mastoid, taking care not to cut away the descendens noni and communicantes noni nerves, which cross the sheath of the common carotid. Dissect out the lymphatic glands which lie along the sheath of the large vessels.

Parts exposed beneath the Sterno-mastoid. The objects exposed to view, when the muscle is reflected, are very numerous. Among these the more important are: the splenius capitis and colli, the posterior belly of the digastricus, the levator anguli scapulæ, scalenus medius and anticus, omo-hyoid, sterno-hyoid, and sterno-thyroid muscles; the occipital artery, the common carotid artery and its division, the internal jugular vein, the subclavian artery and the branches of the first part of its course, the cervical plexus, and the lower cervical nerves which form the brachial plexus; the phrenic, pneumogastric, hypoglossal, and spinal accessory nerves, the descendens and communicantes noni nerves; the subclavian vein and its tributaries; and lastly, a small part of the parotid gland, and the three sterno-mastoid arteries. On the left side, in addition, we find the thoracic duct.

Course and Relations of the Common Carotid. The *common carotid* arises on the right side from the arteria innominata behind the upper part of the right sterno-clavicular articulation; on the left, from the arch of the aorta. It ascends in front of the bodies of the cervical vertebræ, by the side of the trachea, thyroid gland, and larynx, as high as the upper border of the thyroid cartilage, and then divides into the external and internal carotid. Thus a line drawn from the sternal end of the clavicle to a point midway between the mastoid process and the angle of the jaw, will nearly indicate its course. It is contained in a sheath of the deep cervical fascia. In the same sheath are the internal jugular vein and the pneumogastric nerve. The vein lies on the outer side of, and parallel with, the artery: the nerve lies behind, and between the artery and the vein. Behind the sheath are the sympathetic nerve, the inferior thyroid artery, and the recurrent laryngeal nerve. Lastly, along the vertebral column the sheath lies successively upon the longus colli and the rectus capitis anticus major muscles. Owing to the increasing breadth of the larynx, the two common carotid arteries, which at their origin lie near together, are separated by a wide interval at their point of division.

At the lower part of the neck the carotid artery is deeply seated; it is covered by the superficial fascia, platysma myoides,

deep fascia, the sternal portion of the sterno-mastoid, the sterno-hyoid, and thyroid muscles, and, on a level with the cricoid cartilage, it is crossed by the omo-hyoid. Above this point the artery becomes more superficial, and is covered by the platysma, the cervical fascia, the middle sterno-mastoid artery, and only slightly overlapped by the sterno-mastoid. Lying upon the sheath of the artery, we find the descendens noni joined by the communicantes noni nerves. The sheath is crossed by three veins; namely, the facial, the superior, and inferior* thyroid veins, which empty themselves into the internal jugular. This is the general rule, and especial attention should be directed to it, because the veins are liable to be overlooked and injured in the operation of tying the carotid. To the inner side of the artery we find the trachea, the thyroid body, the recurrent laryngeal nerve, the inferior thyroid artery, the external laryngeal nerve, and the inferior constrictor of the pharynx.

It is evidently easier to tie the common carotid above the omo-hyoid than below it. In the higher operation we make an incision (two and a half inches long) along the inner border of the sterno-mastoid, the centre of the incision being opposite the cricoid cartilage; we cut through the platysma and cervical fascia, draw aside the overlapping edge of the sterno-mastoid, and expose the sheath of the vessel. A small opening is then made on the inner side of the sheath large enough to admit the aneurysmal needle, and the vessel is tied, care being taken not to include the pneumogastric or descendens noni nerves in the ligature.

In what respects the Left Carotid differs from the Right.

In the first part of its course the left carotid differs from the right in the following particulars:

1. It arises from the arch of the aorta, is therefore longer and deeper seated than the right, and is covered by the first bone of the sternum.

2. It is crossed by the left brachio-cephalic vein.

* The term 'inferior thyroid' vein is restricted in this manual to the vein which corresponds to the inferior thyroid artery.

3. It is in close relation with the œsophagus and the trachea.

4. It is in close relation with the left recurrent nerve.

5. It is in close relation posteriorly with the thoracic duct.

6. It is covered by the thymus gland in early life.

The common carotid as a rule gives off no branch in its course; but, occasionally, the middle sterno-mastoid, or even the superior thyroid, arises from it prior to its division. At its bifurcation it usually presents a slight bulbous enlargement. This dilatation is sometimes so marked, that it might be mistaken for an incipient aneurysm. It is necessary to know that the carotid sometimes divides as low as the level of the cricoid cartilage, and that not unfrequently the division takes place as high as the hyoid bone.*

INTERNAL JUGULAR VEIN. The internal jugular vein is the continuation of the lateral sinus, and returns the blood from the brain. Leaving the skull through the foramen jugulare, where it presents a slight enlargement, the vein descends on the outer side of the carotid, but in the sheath with it, and joins the subclavian vein at nearly a right angle to form the brachio-cephalic or innominate vein. In its course down the neck it receives the pharyngeal, occipital, lingual, facial, superior, and inferior thyroid veins.

Previous to their terminations the internal jugular veins incline somewhat to the right side to meet the corresponding subclavian veins; thus, on the right side, there is a triangular interval between the artery and vein in which is seen the pneumogastric nerve and vertebral artery; on the left side the vein slightly overlaps the artery, thus rendering ligature of the left carotid more difficult than of the right. The internal jugular veins more-

* It is important that we should be aware that the common carotids differ occasionally in their origin. Thus the right may arise in common with the left carotid, or the right may arise separately from the arch of the aorta, in which case the right subclavian is usually transposed. The left may be given off from the innominate artery of the right side, or it may arise in common with the left subclavian, and thus form a left innominate. In transposition of the aorta there is a left innominate, which is given off first, the right carotid and the right subclavian arising as separate branches from the arch.

over advance slightly to meet the subclavian veins, so that they lie on a plane a little anterior to their accompanying arteries. A little before their termination the internal jugulars have a double valve.

DESCENDENS NONI AND COMMUNICANTES NONI NERVES.

The *descendens noni* (p. 30), a branch of the hypoglossal, runs down obliquely over the sheath of the carotid to supply the depressor muscles of the os hyoides. Trace the nerve upwards to see that it leaves the hypoglossal where this nerve curves round the occipital artery. For a short distance the descendens noni lies within the carotid sheath; but, about the level of the os hyoides, it comes through the sheath, and crosses obliquely over the carotid, from the outer to the inner side. The descendens noni is reinforced by one or more nerves termed communicantes noni, derived from the second and third cervical nerves. These communicating branches descend on the outer side of the internal jugular vein, and form generally two loops in front of the carotid sheath, constituting a triangular plexus called the '*ansa hypoglossi*.' From these loops the nerves proceed to the anterior and posterior bellies of the omo-hyoid, to the sterno-hyoid, and sterno-thyroid muscles. A small branch may sometimes be traced proceeding from the descendens noni into the chest to join the cardiac and phrenic nerves.

In some subjects the descendens noni seems to be wanting, in which case it will probably be concealed *within* the carotid sheath: when this happens the reinforcing loops from the cervical nerves will be found behind the internal jugular vein.*

DISSECTION.

The thyroid body should now be examined. To expose it, reflect the sterno-hyoid and thyroid muscles from their insertions, so that they can be replaced if necessary. Next observe the lymphatic glands of the neck, and

* By many anatomists the descendens noni is regarded as the combination of filaments from the hypoglossal and pneumogastric nerves; by some, it is looked upon as a branch of the pneumogastric; and lastly, which is most probable, it is considered by others to be mainly derived from a branch which is sent to the hypoglossal from the first and second cervical nerves.

lastly survey the objects in the central line of the neck, from the jaw to the sternum.

THYROID BODY. This very vascular gland-like body lies over the front and sides of the upper part of the trachea, and extends upwards on each side of the larynx. It consists of *two lateral lobes*, connected a little below the cricoid cartilage by a tranverse portion called the *isthmus*. Each lobe is conical, about two inches in length, with the base opposite the fifth or sixth ring of the trachea, and the apex by the side of the thyroid cartilage. Its anterior surface is covered by the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles; its deep surface embraces the sides of the trachea and larynx, and usually extends so far backwards as to be in contact with the pharynx. Its external border overlaps, in most cases partially, but sometimes completely, the common carotid artery, particularly on the right side; and there are instances in which the lobe is deeply grooved by the vessel.

The isthmus lies over the second and third rings of the trachea. This portion of the organ varies much in its dimensions. In some instances there is no transverse portion. This corresponds with the normal disposition in most of the lower orders of mammalia; but in man, it is a failure in the union of the two halves by which the organ is originally developed.* Generally, the vertical measurement is about half an inch. Between its upper border and the cricoid cartilage is a space about one-third of an inch in extent, where the trachea is free; this space, therefore, is the more preferable situation for tracheotomy. But the vertical measurement of this isthmus is sometimes of very considerable length, so that it has been seen covering the trachea almost down to the sternum.†

* Concerning the development of the lateral halves and central portion of the thyroid body, see a paper by Callender in the Proceedings of the Royal Society, 1867.

† From the upper part of the isthmus, or from the adjacent border of either lobe, most commonly the left, a conical prolongation of the thyroid body, called the *pyramid*, frequently ascends in front of the crico-thyroid membrane, as high as the pomum Adami, and is attached to the body of the os-hyoides by fibrous tissue. In some subjects we may observe a few muscular fibres passing from the os-hyoides to the pyramid. This constitutes the *levator glandulæ thyroideæ* (see preparation in Museum of St. Barth. Hosp., Patholog. Series, No. 14) of some anatomists. There

The thyroid body is closely connected, by areolar tissue, to the sides of the trachea, to the cricoid and thyroid cartilages. Hence it rises and falls with the larynx in deglutition.

The thyroid varies in size in different individuals and at different periods of life. It is relatively larger in the child than the adult, in the female than the male. In old age it diminishes in size, becomes firmer, and occasionally contains earthy matter.

By far the most notable considerations in respect to the thyroid body are the number, the large size, and the free inosculations of its blood-vessels. The superior thyroid arteries come from the external carotid and enter the front surface of the apex of each lobe; the inferior thyroid come from the subclavian, and enter the under surface of the base. An artery, called the middle thyroid (thyroidea ima), is observed in some subjects; it is given off from the arteria innominata, or the arch of the aorta, and ascends directly in front of the trachea to the isthmus.

Its veins are equally large, and form a plexus upon it. The superior and inferior thyroid veins cross the common carotid, and open into the internal jugular. The middle thyroid veins, two in number, descend over the front of the trachea, communicate freely with each other, and terminate in the left brachio-cephalic vein. When you perform tracheotomy, bear in mind the size of these middle thyroid veins, and the possible existence of a middle thyroid artery.

Its nerves are furnished by the laryngeal branch of the pneumogastric and the middle and inferior cervical ganglia of the sympathetic. They accompany the arteries.

STRUCTURE OF THE THYROID BODY.

The thyroid body weighs from one to two ounces, and belongs to the class of ductless glands, since no excretory duct has been discovered. It is invested by a thin covering of dense connective tissue which

are instances in which the pyramid is double; and, lastly, we have seen a considerable portion of this thyroid substance lying over the crico-thyroid membrane, completely isolated from the rest of the organ. These varieties deserve notice, because any one portion of this structure may become enlarged independent of the rest, and occasion a bronchocele.

penetrates it, imperfectly dividing it into lobes and supporting the vessels as they enter it. It consists of a multitude of cells, which vary in size, from $\frac{1}{850}$ inch to that of a pin's head, and do not communicate with each other. In hypertrophy of the gland we sometimes see them as large as a horsebean, or even larger. The cells are oval and are lined by a single layer of endothelial cells resting upon a basement membrane, and contain a glairy transparent fluid, in which are found a large number of nuclei and nucleated cells. The arteries ramify most minutely upon their walls. Of its functions nothing is definitely known, but probably it is concerned in the elaboration of the blood.*

An enlargement of the thyroid body is termed a 'bronchocele.' If the relation of its lobes to the trachea and œsophagus be properly understood, it is easy to predicate the consequences which may result from their enlargement. The nature and severity of the symptoms will to a certain extent be determined by the part of the organ affected. If the isthmus be enlarged, difficulty in breathing will probably be the prominent symptom; and an enlargement of the left lobe is more likely to produce a difficulty in swallowing, on account of the inclination of the œsophagus towards the left side.

An instance is related by Allan Burns in which the isthmus was placed between the trachea and the œsophagus. It must be obvious that enlargement of a part so situated would occasion great difficulty in swallowing. I have seen two cases in which the lateral lobes projected so far inwards that they completely embraced the back of the œsophagus.

Small lymphatic glands are observed about the thyroid body, especially in front of the trachea; one is often situated over the crico-thyroid membrane. These glands, if enlarged by disease, might be mistaken for a small bronchocele.

DEEP CERVICAL LYMPHATIC GLANDS.

In the connective tissue which surrounds the great vessels of the neck, we meet with a series of lymphatic glands, called the deep cervical.

* The thyroid body is, primarily, developed as a pouch from the anterior wall of the pharynx; the lateral lobes are first formed, and are subsequently united by the isthmus. W. Müller, 'Jenaisch. Zeitsch.' 1871.

They form an uninterrupted chain (whence their name *glandulæ concatenatæ*), from the base of the skull, along the side of the neck, to the clavicle, beneath which they are continuous with the thoracic and the axillary glands. Some of these glands lie anterior to the common carotid artery; others, between it and the spine. This disposition explains the well-known fact, that, when these glands are enlarged, the great vessels and nerves of the neck are liable to become imbedded in their substance.

The glands are particularly numerous near the division of the common carotid, by the side of the pharynx, and the posterior belly of the digastricus. The lymphatics connected with them come from all parts of the head and neck. These vessels unite, to form, on both sides of the neck, one or more absorbent trunks, called the jugular. On the left side this jugular trunk joins the thoracic duct, or opens by a separate orifice into the left subclavian vein: on the right it always opens into the subclavian vein.

The contiguity of the glands to the great vessels and nerves of the neck explains the symptoms produced by their enlargement. The tumour may be so situated as to be raised and depressed by the pulsation of the carotid, and thus simulate an aneurysm. A careful examination, however, will distinguish between an inherent and a communicated pulsation. By grasping the tumour we become sensible that the pulsation does not depend upon any variation of its magnitude, but upon the impulse derived from the artery; consequently, if the tumour be lifted from the vessel, all feeling of pulsation ceases.

SURVEY OF THE CENTRAL LINE OF THE NECK. The parts in the central line of the neck should now be well studied (fig. 8, p. 30). Beginning at the chin, we observe the insertions of the digastric muscles. Below these is the junction, or raphé, of the mylo-hyoid muscles. Then comes the os hyoides. Below the os hyoides is the thyro-hyoid membrane, attached above to the upper border of the hyoid bone, and below to the thyroid cartilage. Next is the pomum Adami, or projection of the thyroid cartilage, which is apparent between the contiguous borders of the sterno-hyoidei. Below the thyroid cartilage is the cricoid. These two

cartilages are connected by the crico-thyroid membrane, across which runs the crico-thyroid artery to join its fellow. Below the cricoid cartilage is the trachea. This is crossed by the isthmus of the thyroid body, and lower down it recedes from the surface, covered by the middle thyroid veins.

Now the chief surgical interest lies just above, and just below, the cricoid cartilage. This cartilage can be felt very plainly in the living subject at any age, no matter how fat. In laryngotomy, the crico-thyroid membrane is divided transversely. The membrane should be divided *close* to the edge of the cricoid c., for two reasons: 1. In order to be farther from the vocal cords. 2. To avoid the crico-thyroid artery which crosses the middle of the membrane. If more room be required, the cricoid cartilage should be divided longitudinally.

In tracheotomy, the trachea may be opened by a perpendicular incision, above the isthmus of the thyroid body, or below it. The operation above the isthmus, if there be space enough for the introduction of the tube, is the easier and safer of the two; for here the trachea is nearer to the surface, and no large blood-vessels are, generally speaking, in the way. The space available measures from a quarter to half an inch; and the isthmus is not so firmly adherent to the trachea as to prevent its being drawn downwards for a short distance. However, it is right to state, that in one case out of every eight or ten, there is *no* available space.

Tracheotomy below the isthmus is neither an easy nor a safe operation, for many reasons: 1. The trachea recedes from the surface as it descends, so that just above the sternum it is nearly an inch and a half from the skin. 2. The large middle thyroid veins are in the way. 3. A middle thyroid artery may run up in front of the trachea, direct from the arteria innominata. 4. The arteria innominata itself lies sometimes upon the trachea higher than usual, and may, therefore, be in danger. 5. The left brachio-cephalic vein in some cases crosses the trachea above the edge of the sternum instead of below it. The celebrated French surgeon Béclard used to relate in his lectures the following occurrence:

A student had fallen into the Seine, and was nearly drowned. As he was recovering very gradually, some kind friends attempted to accelerate the process by making an opening into the trachea. In so doing they wounded the brachio-cephalic vein. Blood poured into the trachea, and the result was instantly fatal.

Whoever pays attention to this subject in the dissecting-room will soon be convinced of the fact, that not only large veins but large arteries occasionally cross the crico-thyroid membrane as well as the trachea, thus showing the necessity of cutting *cautiously* down to, and fairly exposing the air tube, before we venture to open it.*

DISSECTION OF THE SUBMAXILLARY REGION, OR THE DIGASTRIC TRIANGLE.

When the platysma and the cervical fascia have been removed from their attachment to the jaw, the most conspicuous object is the submaxillary gland. Observe that the fascia forms for it a complete capsule. Beneath the jaw are several lymphatic glands, from six to ten in number, of which some lie superficial to the salivary gland, others beneath it. These glands receive the lymphatics of the face, the tonsils, and the tongue.

A little dissection will expose a muscle called the digastricus, consisting of two distinct portions connected by a tendon. They form, with the body of the jaw, a triangle, called the *digastric*, of which we propose to examine the contents. And first of the digastric muscle itself.

DIGASTRICUS.

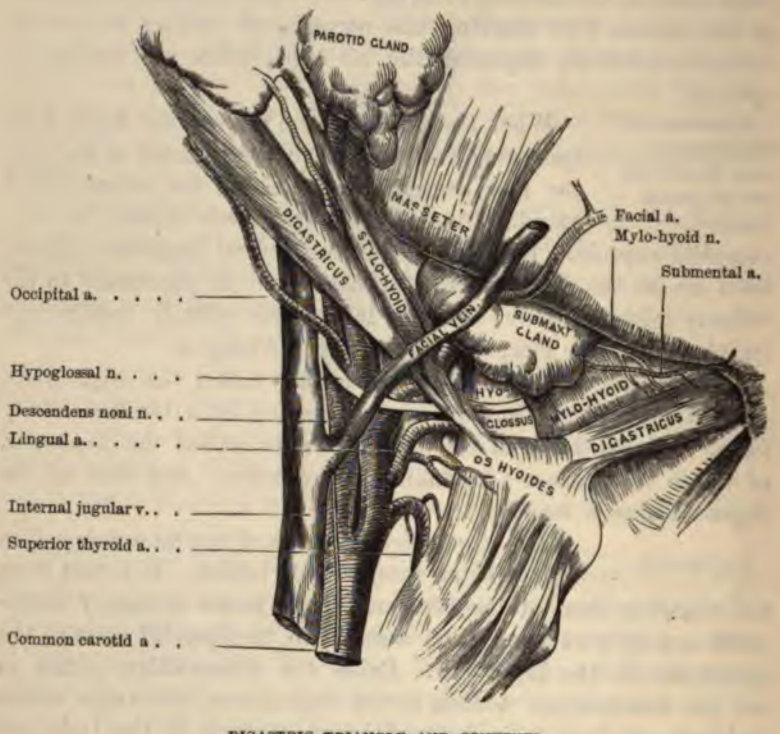
The *digastricus* consists of two muscular bellies united by an intermediate tendon. It *arises* from the digastric fossa of the temporal bone, passes obliquely downwards and forwards, and then ascends to be *inserted* close to the symphysis of the lower jaw. Raise the submaxillary gland to see the intermediate tendon of the digastricus, the angle which it forms, and how it is fastened by aponeurosis to the body and greater cornu of the os hyoides. Observe also that this aponeurosis

* It is preferable, after making the first incision through the skin, to lay aside the sharp knife and to use a blunt one, so that the tissues may be torn rather than cut; by this proceeding the liability to hæmorrhage is materially lessened.

is connected in the mesial line with its fellow of the opposite side, so that a fibrous expansion occupies the interval between the anterior portions of the digastrici.

The chief action of the digastricus is to depress the lower jaw. But if the lower jaw be fixed, then the muscle raises the os hyoides, as in deglutition.

FIG. 9.



DIGASTRIC TRIANGLE AND CONTENTS.

The posterior belly of the digastricus is supplied by a nerve from the facial; the anterior belly by a branch from the mylohyoidean nerve (which comes from the third division of the fifth pair).

STYLO-HYOIDEUS. The stylo-hyoideus *arises* from the middle of the styloid process of the temporal bone, and is *inserted* into the body of the os hyoides. This muscle runs close along, but above, the posterior belly of the digastricus. Most frequently the digastric tendon runs through the substance of it. Its nerve is derived from the facial close to its exit from the stylo-mastoid foramen, in common with the branch to the posterior belly of the digastricus. Its action is to raise and draw back the os hyoides.

The digastric triangle is bounded above by the horizontal ramus of the lower jaw, parotid gland, and mastoid process of the temporal bone; behind by the posterior belly of the digastricus; and in front by the anterior belly. The objects to be examined in this triangle are twelve in number, as follow:

1. Submaxillary salivary gland.	7. Stylo-maxillary ligament.
2. Facial vein.	8. Part of the parotid gland.
3. Facial artery.	9. Part of the external carotid artery.
4. Submental artery.	10. Mylo-hyoideus muscle.
5. Mylo-hyoidean nerve.	11. Hypoglossal nerve.
6. Submaxillary lymphatic glands.	12. Part of the hyo-glossus muscle.

SUBMAXILLARY SALIVARY GLAND. In the ordinary position of the head, the submaxillary gland is partially concealed by the jaw, but when the head falls back the gland is more exposed. It is about the size of a chestnut, and is divided into several lobes. Its upper margin is covered by the body of the jaw; its lower margin overlaps the side of the os hyoides. Its cutaneous surface is flat, being covered only by the skin and platysma, but the lobes on its deep surface are irregular, and often continuous with those of the sublingual gland. By raising the gland we find that it lies upon the mylo-hyoideus, the hyo-glossus, the stylo-glossus, the tendon of the digastricus, and a portion of the hypoglossal nerve, seen above the tendon. The facial artery lies in a groove on its deeper surface and subsequently upon its upper border; and it is separated from the parotid gland, which is situated behind it, by the stylo-maxillary ligament. Mark these relations well, because

they are of importance, as will be presently explained, in tying the lingual artery.

The duct of the gland, *Wharton's duct*,* passes from its under surface, runs forwards under the mylo-hyoideus and upon the hyo-glossus muscle; it then passes beneath the gustatory nerve, and subsequently runs between the sublingual gland and the genio-hyo-glossus, to open into the floor of the mouth, by the side of the frænum linguæ. Its length is about two inches; its dimensions are not equal throughout; it is dilated about the middle, and contracted at the orifice. Saliva, collected in the dilated portion, is sometimes spirted to a considerable distance out of the narrow orifice, in consequence of the sudden contraction of the neighbouring muscles.

In the floor of the mouth there occasionally exists a cystic tumour, called a *ranula*, with semi-transparent walls, perceptible beneath the tongue. By some of the older writers it was looked upon as an abnormal dilatation of the submaxillary duct. There is, however, no reason for believing this swelling (except very rarely) to be connected with the duct. It is rather a cyst formed in the loose areolar tissue under the tongue, or is an enlargement of one of the small bursæ which normally exist in this situation. The character of the saliva presents no agreement with the fluid contained in these cysts, which is thickly glairy, like the white of an egg.†

FACIAL VEIN.

The facial vein does not accompany the facial artery, but runs nearly a straight course. It leaves the face at the anterior edge of the masseter m., then runs *over* the submaxillary gland, the digastricus and stylo-hyoideus and the carotid artery, to join the internal jugular. This is the rule—but there are frequent exceptions. The principal point to remember is, that the vein runs superficial to the gland, and that we must be cautious in opening abscesses under the jaw.

* Thom. Wharton, 'Adenographia, seu glandularum totius corporis descriptio.' 12mo. Amstel., 1659.

† These sublingual bursæ were first described by Fleischmann, 'De novis sub lingua bursis,' Nuremberg, 1841.

FACIAL ARTERY. The *facial artery* is the third branch of the external carotid. It runs tortuously under the hypoglossal nerve, the posterior belly of the digastricus and stylo-hyoideus, and beneath or through the substance of the submaxillary gland to the face, where it appears at the anterior border of the masseter. Below the jaw the facial gives off the four following branches:

1. The *ascending or inferior palatine artery* runs up between the stylo-glossus and the stylo-pharyngeus m. to the pharynx, to which and the neighbouring parts it gives branches. Ascending as far as the levator palati, it divides into two branches; one courses along the tensor palati to supply the soft palate, the other enters the tonsil, and anastomoses with the descending palatine and the tonsillar branches of the ascending pharyngeal.

2. The *tonsillar* runs up between the internal pterygoid and the stylo-glossus m., then, perforating the superior constrictor, it supplies the tonsil and root of the tongue.

3. *Glandular* branches to the submaxillary gland and side of tongue.

4. The *submental* arises from the facial behind the submaxillary gland, and runs forwards upon the mylo-hyoideus, beneath the inferior maxilla, distributing branches in its course to the gland and the adjacent muscles. It then curves over the bone and divides into two branches: a superficial one, which supplies the skin and lip; and a deep one, which runs between the muscles and the bone, and inosculates with the mental and inferior labial arteries. Beneath the inferior maxilla it usually inosculates with the sublingual artery.

MYLO-HYOIDEAN NERVE. Look for the mylo-hyoidean nerve near the submental artery. The nerve comes from the inferior dental (before its entrance into the dental foramen), and running along a groove on the inner side of the inferior maxilla, advances between the bone and the internal pterygoid m., to supply the mylo-hyoideus and the anterior belly of the digastricus.

SUBMAXILLARY LYMPHATIC GLANDS. The submaxillary lymphatic glands receive the lymphatics of the face and the tongue. They are often enlarged in cancerous diseases of the tongue

or the lower lip. It should be remembered also that there are lymphatic glands in the mesial line below the chin.

MYLO-HYOIDEUS. The mylo-hyoideus *arises* from the mylo-hyoid ridge of the lower jaw, as far back as the last molar tooth. Its posterior fibres are *inserted* into the body of the os hyoides, the anterior being attached to a median tendinous line, termed the *raphé*. Thus the muscles of opposite sides form a muscular floor for the mouth. It is supplied with nerves by the mylo-hyoid branch of the inferior dental; with blood by the submental a. The muscles of opposite sides conjointly elevate the os hyoides and the floor of the mouth—as in deglutition.

STYLO-MAXILLARY LIGAMENT. This is a layer of the deep cervical fascia, extending from the angle of the jaw to the styloid process. It is a broad sheet of fascia, and separates the submaxillary gland from the parotid. It is continuous with the fascia covering the pharynx; this gives it a surgical interest, because it prevents accumulations of matter formed near the tonsils and upper part of the pharynx from coming to the surface.

The remaining objects seen in the submaxillary triangle, namely, the parotid gland, the external carotid, the hypoglossal nerve, and the hyo-glossus muscle, will be described presently when they can be better seen. Your attention should now be directed to a piece of surgical anatomy, which will enable you readily to find and tie the lingual artery. It is this:

A curved incision about two inches in length being made from the lesser cornu along the upper border of the great cornu of the os hyoides, through the skin, the platysma, and the cervical fascia, you will come upon the lower edge of the submaxillary gland. Lift up the gland, which is easily done, and underneath it you will observe that the tendon of the digastricus makes two sides of a triangle, of which the base is formed by the hypoglossal nerve crossing the hyo-glossus m. Within this little triangle, cut transversely through the fibres of the hyo-glossus: under them is the lingual artery, lying on the middle constrictor. The first time you perform this operation on the dead subject, you will not

unlikely miss the artery and cut through the middle constrictor into the pharynx.

DISSECTION. The facial vessels must now be divided immediately below the jaw. Reflect the anterior belly of the digastricus from its insertion; detach the mylo-hyoideus from the middle line and the os hyoides, and turn it over the body of the jaw, taking care not to injure the muscle and structures beneath. The lower jaw must now be sawn through, a little to one side of the symphysis, and the bone drawn upwards by hooks. The tongue should then be drawn out of the mouth, and fastened by hooks. The os hyoides should be drawn down by means of hooks, so as to put the parts on the stretch. All this done, we have to make out, by carefully cleaning away the fat and connective tissue, the following objects represented in fig. 10, p. 48:

1. Genio-hyoideus.	6. Sublingual gland.
2. Hyo-glossus.	7. Hypoglossal nerve.
3. Stylo-glossus.	8. Gustatory nerve.
4. Genio-hyo-glossus.	9. Submaxillary ganglion.
5. Submaxillary duct.	10. Lingual artery.

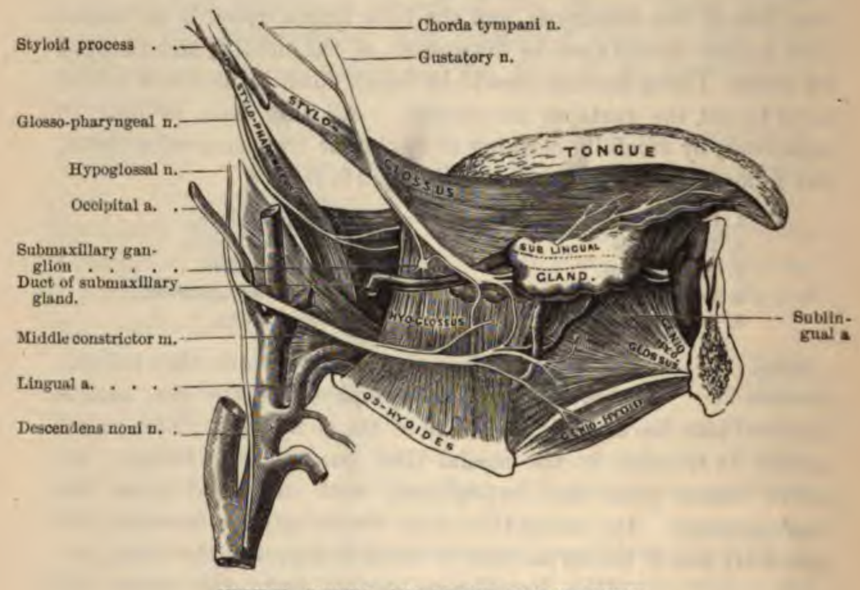
GENIO-HYOIDEUS. The genio-hyoideus *arises* from the inferior tubercle behind the symphysis of the jaw, and is *inserted* into the front of the body of the os hyoides. This round muscle is situated in the mesial line, parallel to its fellow. Its nerve comes from the hypoglossal, and its blood from the lingual artery. Its action is to draw the os hyoides forwards and upwards; and if the hyoid bone be fixed, it depresses the lower jaw.

HYO-GLOSSUS. The hyo-glossus *arises* from the body, the greater and lesser cornua of the os hyoides, and is *inserted* into the posterior two-thirds of the side of the tongue, its fibres blending with the stylo-glossus and palato-glossus. It is a square and flat muscle, and its fibres ascend nearly perpendicularly from origin to insertion.* Its nerve comes from the hypoglossal, and its blood from the lingual artery. Its action (with that of its

* Some anatomists ascribe the following names to the different origins of this muscle: that from the body of the hyoid bone is termed the *basio-glossus*, that from the greater cornu the *cerato-glossus*, and that from the lesser cornu the *chondro-glossus*.

fellow) is to depress the tongue. Observe the several objects which lie *upon* the hyo-glossus; namely, the hypoglossal and gustatory nerves (which at the anterior border form one or more loops of communication), the submaxillary ganglion, the duct of the submaxillary gland, and the sublingual gland. *Beneath* the hyo-glossus muscle lie the lingual artery, part of the middle constrictor

Fig. 10.



MUSCLES, VESSELS, AND NERVES OF THE TONGUE.

of the pharynx, part of the genio-hyo-glossus, the lingualis muscle, and the glosso-pharyngeal nerve.

GENIO-HYO-GLOSSUS. The genio-hyo-glossus *arises* by a tendon from the upper tubercle behind the symphysis of the lower jaw, and is *inserted* as follows: the lower fibres into the body of the os hyoides; the upper fibres into the tongue from the base to the apex. It is the largest and most important of the muscles of the tongue. It is fan-shaped, with the apex attached

to the symphysis: thence its fibres radiate into the entire length of the tongue. It derives its nerves from the hypoglossal, and its blood from the lingual artery. Its action is various. The posterior fibres, by raising the os-hyoides and drawing forwards the base of the tongue, protrude the tongue out of the mouth; the anterior draw the tongue back again. When every part of the muscle acts, it draws down the whole tongue, and is therefore one of the chief muscles concerned in suction.

STYLO-GLOSSUS. The stylo-glossus, a long and slender muscle, *arises* from the apex of the styloid process and the stylo-maxillary ligament, and is *inserted* along the side of the tongue. It runs outside the hyo-glossus nearly to the tip of the tongue, and blends with the fibres of this muscle, as well as with the palato-glossus. Its nerve comes from the hypoglossal. Its action is to retract the tongue.

HYPOGLOSSAL NERVE. The hypoglossal, or ninth cranial nerve, is the *motor* nerve of the muscles of the tongue. It arises (by several roots) from the front of the medulla oblongata between the pyramid and the olive. After leaving the skull through the anterior condyloid foramen (by two fasciculi which subsequently blend), it lies beneath the internal jugular vein and internal carotid artery, where it is intimately connected with the lower ganglion of the pneumogastric nerve; it then comes up between the artery and vein, and, immediately below the posterior belly of the digastricus, curves forwards over the occipital, the internal and external carotid and facial, arteries. Next it crosses the hyo-glossus muscle, and passing beneath the mylo-hyoid, divides into branches which supply the following muscles; namely, the stylo-glossus, hyo-glossus, genio-hyo-glossus, lingualis, and the genio-hyoideus.

As it curves round the occipital artery, the hypoglossal nerve sends the *descendens noni* to the depressors of the os hyoides (p. 30). It also sends a nerve to the thyro-hyoideus, which proceeds from it where it crosses over the external carotid, accompanied by the hyoid branch of the lingual artery. Near the anterior border

of the hyo-glossus, it communicates by one or more loops with the gustatory nerve. (Fig. 10.)

The hypoglossal at its origin is purely a *motor* nerve. But after leaving the skull, it receives communications from the first two cervical nerves. These communications are important physiologically for two reasons: 1. They account for the hypoglossal nerve containing sensory fibres. 2. They contribute the greater part of the filaments of the descendens noni. It is also connected by small branches with the pneumogastric nerve and the superior cervical ganglion of the sympathetic at the base of the skull.

SUBLINGUAL GLAND. The sublingual gland lies immediately beneath the mucous membrane of the floor of the mouth. Its shape is oblong, with the long axis (about an inch and a half) directed from before backwards. It rests upon the upper surface of the mylo-hyoid muscle, and towards the mesial line it is in contact with the hyo-glossus and the genio-hyo-glossus.

The ducts of the sublingual gland (ducts of Rivinus*) vary in number from eight to twenty. They terminate by minute openings behind the orifice of the submaxillary duct, along the ridge felt upon the floor of the mouth. The ducts of some of the lobes terminate in the submaxillary duct.

The duct of the submaxillary gland may now be traced across the hyo-glossus, and under the gustatory nerve to the floor of the mouth.

LINGUAL OR GUSTATORY NERVE. This nerve is a branch of the inferior maxillary or third division of the fifth pair of cranial nerves. Emerging beneath the external pterygoid m., it descends between the ramus of the jaw and the internal pterygoid muscle, and comes forwards over the superior constrictor of the pharynx and along the upper part of the hyo-glossus, crossing at an acute angle over the duct of the submaxillary gland. (Fig. 10.) Having reached the under part of the tongue, the nerve divides into filaments which supply the papillæ on its anterior three-fourths. Beneath the external pterygoid it is joined at an acute angle by the chorda tympani, and in its course it gives off some com-

* Aug. Quirin. Rivinus, 'de Dyspepsia.' Lips. 1678.

municating branches to the hypoglossal nerve near the anterior border of the hyo-glossus. It supplies also the mucous membrane of the mouth, gums, and the sublingual gland, and at the apex of the tongue the terminal branches of this nerve and the hypoglossal are connected.

SUBMAXILLARY GANGLION. At the lower border of the gustatory nerve before it crosses the submaxillary duct, you will find a small ganglion, about the size of a pin's head. Like the other ganglia in connection with the branches of the fifth pair, it receives filaments of three different kinds—viz. motor, sensory, and sympathetic. Its motor root is the chorda tympani, which, apparently a branch of the gustatory, is derived from the facial nerve. Its sensory roots proceed from the gustatory; and its connection with the sympathetic system is established by a branch which comes from the nervi molles round the facial artery. The ganglion supplies five or six branches to the submaxillary gland and its duct. It also supplies the mucous membrane of the floor of the mouth.*

LINGUAL ARTERY. The lingual artery is generally the second branch of the external carotid. Curving slightly upwards from its origin, the artery soon runs forwards beneath the posterior belly of the digastricus, and stylo-hyoideus, and then passes beneath the hyo-glossus m., parallel to the os hyoides. At the anterior edge of the hyo-glossus it ascends to the under surface of the tongue, and is continued forwards to the apex of the tongue under the name of *ranine*. Under the hyo-glossus, the artery lies upon the middle constrictor of the pharynx, and the genio-hyo-glossus; in the substance of the tongue, it lies between the genio-hyo-glossus and the inferior lingualis. The curves made by the artery are for the purpose of allowing the elongation of the tongue. Its branches are:

1. The *hyoid*, a small artery which runs along the upper border of the hyoid bone, supplying the muscles and anastomosing with its fellow.

* Meckel describes a small branch of the ganglion which sometimes passes forwards to join a branch of the hypoglossal, on the hyoglossus m., and ends in the genio-hyo-glossus.

The nerve to the thyro-hyoid muscle, which is derived from the hypoglossal, accompanies this artery.

2. The *dorsales linguæ*, two or more, run under the hyo-glossus to the back of the tongue.

3. The *sublingual*, arising near the anterior border of the hyo-glossus, supplies the sublingual gland, the mylo-hyoideus, and the mucous membrane of the mouth and gums. This artery generally gives off the little artery of the frænum linguæ, which is sometimes wounded in cutting the frænum in children who are tongue-tied; especially when we neglect the rule of pointing the scissors downwards and backwards.

4. The *ranine* is the termination of the lingual artery. As it runs forwards to the tip of the tongue along the outer side of the genio-hyo-glossus, it distributes branches to the tongue, and at the tip inosculates slightly with its fellow.

The *lingual* or *ranine vein* commencing at the tip of the tongue, runs along its under surface *over* the hyo-glossus, and terminates in the internal jugular vein.

The best place for finding and tying the lingual artery has been mentioned (p. 46). The rule laid down is trustworthy only when the artery runs its normal course. We have known an instance in which a good anatomist failed in an attempt to tie the lingual artery, because the vessel arose from the facial behind the submaxillary gland, and then passed through the mylo-hyoideus to reach the tongue.

The course and relations of the external carotid artery, and its branches in the neck, should now be made out. In preparing a view of them, observe that nearly all the veins lie *in front* of their corresponding arteries. In removing the connective tissue and lymphatic glands, the student must take care of the nerves and other structures which are liable to be injured.

COURSE AND RELATIONS OF THE EXTERNAL CAROTID ARTERY. The external carotid arises from the common carotid about the level of the upper border of the thyroid cartilage. It ascends to the interval between the ear and the jaw, and, at first, lies beneath the sterno-mastoid, the cervical fascia, the platysma myoides, and some branches of the superficial nerves. It is next

crossed by the hypoglossal nerve, the facial and lingual veins, the posterior belly of the digastricus and stylo-hyoideus; it then enters the parotid gland, where it lies beneath the facial nerve and external jugular vein, and terminates near the neck of the jaw, by dividing into the temporal and internal maxillary arteries.

The external carotid is separated from the internal, by the stylo-glossus and stylo-pharyngeus, the glosso-pharyngeal nerve and the stylo-hyoid ligament. The superior laryngeal nerve lies under both vessels.

Notice the relative position which the external and internal carotids bear to each other. The external lies at first on the same plane with, but nearer to the side of the pharynx than the internal. It soon, however, changes its position, and crosses obliquely in front of the internal to reach the space between the angle of the jaw and the mastoid process. The internal carotid ascends perpendicularly by the *side of the pharynx* to the base of the skull.

The external carotid gives off the following branches:

1. The superior thyroid.
2. The lingual.
3. The facial.
4. The occipital.
5. The posterior auricular.
6. The internal maxillary.
7. The temporal.
8. The ascending pharyngeal.

SUPERIOR THYROID ARTERY. The superior thyroid, the first branch of the external carotid, arises just below the great cornu of the os hyoides. It lies in the superior carotid triangle, and runs beneath the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles to the upper and front surface of the thyroid body, in which it terminates. Its branches are the four following:

1. The *hyoid*, a small muscular branch, runs horizontally inwards below the greater cornu of the os hyoides, and anastomoses with its fellow.

2. The *superior laryngeal* branch, accompanied by the superior laryngeal nerve, runs beneath the thyro-hyoid muscle, pierces the thyro-hyoid membrane (sometimes the thyroid cartilage), and supplies the muscles and the mucous membrane of the larynx.

3. The *middle sterno-mastoid*, a small branch, variable as to origin, descends over the sheath of the carotid artery to the mastoid muscle.

4. The *crico-thyroid*, an artery of great interest in reference to the operation of laryngotomy, crosses the crico-thyroid membrane, and communicates with a corresponding branch on the opposite side. (Fig. 8, p. 30.) One or two small branches pass through the membrane to the interior of the larynx. It is important to know that the crico-thyroid artery often varies in direction and size. In most cases it is small, and runs across the centre of the membrane; we should therefore be least likely to wound it in laryngotomy, by dividing the membrane close to the cricoid cartilage. But it is by no means infrequent to find this artery of considerable size, taking an oblique or even a perpendicular direction in front of the membrane, and finally distributed to one of the lobes of the thyroid body. We have seen several instances in which the membrane was crossed by the main trunk of the superior thyroid. These facts should establish the practical rule in laryngotomy, not to make an opening into the larynx until it has been fairly exposed.

Among the many arterial inosculations about the thyroid body are two which deserve notice: the one is formed between the two superior thyroid arteries along the upper border of the isthmus, the other takes place along the back part of the lateral lobe between the superior and inferior thyroid arteries of the same side.

The *superior thyroid vein* crosses transversely the sheath of the common carotid, and joins the internal jugular.

SUPERIOR LARYNGEAL NERVE. The superior laryngeal nerve, mentioned as accompanying the superior laryngeal artery, is given off from the inferior ganglion of the pneumogastric. It descends by the side of the pharynx, behind both carotid arteries, and divides into two branches, the internal and external laryngeal nerves. The *internal branch* enters the larynx through the thyro-hyoid membrane accompanied by the superior laryngeal artery, and supplies the mucous membrane of the larynx with its exquisite sensibility. Some of its branches may be traced upwards in the ary-epiglottidean fold to supply the epiglottis and base of the tongue; others descend to the rima glottidis; a large branch passes down behind the ala of the thyroid cartilage

to join the recurrent laryngeal nerve; and a small branch pierces the arytenoideus to supply the mucous membrane beneath it. The *external branch* accompanies the crico-thyroid artery, and after distributing filaments to the pharyngeal plexus, supplies the inferior constrictor and the crico-thyroid muscles.

LINGUAL ARTERY. The lingual artery and its branches have been described (p. 51).

FACIAL ARTERY. The facial artery and its branches below the jaw have also been described (p. 45).

OCCIPITAL ARTERY. The occipital artery arises from the posterior part of the external carotid, usually opposite the facial artery and runs backwards along the lower border of the digastricus towards the mastoid process. It then passes under all the muscles inserted into the mastoid process—namely, the sterno-mastoid, the splenius capitis, the trachelo-mastoid, and the digastric. Arrived at the back of the head, the artery runs superficial to the superior oblique, the rectus capitis posticus major and the complexus, and divides into wide-spreading branches for the supply of the scalp. In the first part of its course, the occipital artery crosses over the internal carotid artery, the internal jugular vein, the pneumo gastric and the spinal accessory nerves, and is itself crossed by the hypoglossal nerve. It sends off the six following branches:

1. The *superior sterno-mastoid*, which enters the muscle with the nervus accessorius.

2. The *auricular* ramifies on the cranial aspect of the concha.

3. The *posterior meningeal* ascends with the internal jugular vein, and enters the cranium through the foramen jugulare to supply the dura mater of the posterior fossa.

4. The *princeps cervicis*, which we shall see better hereafter, is a short trunk which runs down the back of the neck, and divides into two branches —a superficial, lying beneath the splenius, and supplying also the trapezius, and a deep branch lying under the complexus, and anastomosing with the deep cervical artery between this muscle and the semi-spinalis colli.

5. The *mastoid* enters the foramen in the mastoid process, and supplies the dura mater.

6. The *cranial* branches supply the scalp on its posterior aspect.

The *occipital vein* usually terminates in the internal jugular, occasionally in the external jugular vein.

POSTERIOR AURICULAR ARTERY. The posterior auricular artery, the fifth branch, is given off from the posterior part of the external carotid. It arises above the digastricus, lies on the styloid process, and under cover of the parotid gland reaches the furrow between the cartilage of the ear and the mastoid process. Before it reaches the furrow, it is crossed by the facial nerve, and just beneath it is the spinal accessory. Above the mastoid process it divides into two branches, a posterior inosculating with the occipital, and an anterior communicating with the temporal. It supplies the back of the scalp and the cartilage of the ear. It gives off—

1. Small branches to the digastricus, stylo-hyoid, and the parotid gland.
2. The *stylo-mastoid*, a very constant little artery, which runs through the stylo mastoid foramen to supply the mastoid cells, the vestibule, and the membrana tympani, inosculating with the tympanic branch of the internal maxillary.
3. The *auricular* branches, which supply both surfaces of the auricle.

POSTERIOR AURICULAR NERVE. The posterior auricular nerve lies close to the artery of the same name. It is the first branch of the seventh or facial nerve after its exit from the stylo-mastoid foramen. It runs behind the ear and divides into an *auricular* branch to the retrahens and the attollens aurem, and an *occipital* branch to the posterior belly of the occipito-frontalis. The nerve is connected with the auriculo-parotidean branch of the cervical plexus, and with the auricular branch of the pneumogastric nerve.

ASCENDING PHARYNGEAL ARTERY. This long and straight branch arises about half an inch above the division of the common carotid. It ascends between the internal carotid and the side of the pharynx to the base of the skull, lying upon the rectus capitis anticus major. It gives off numerous branches; among them are:

1. *Small branches* which pass outwards to supply the anterior recti muscles, the superior cervical ganglion, the pneumogastric and hypoglossal nerves.

2. *Pharyngeal branches*, which pass to the pharyngeal muscles; one, the largest of all, enters the pharynx above the superior constrictor, and terminates in the soft palate, the Eustachian tube, and the tonsils.

3. *A meningeal branch*, which passes through the foramen lacerum posticum, and is distributed to the dura mater of the occipital fossa.

The examination of the two remaining branches of the external carotid, the internal maxillary and temporal, must for the present be postponed. Meanwhile the student should make out the deep cervical plexus and its branches.

CERVICAL PLEXUS OF NERVES.

This plexus is formed by the anterior branches of the four upper cervical nerves. It consists of a series of loop-like communications, between these nerves, close to the transverse processes of the four upper cervical vertebræ: each nerve dividing into an ascending and a descending branch, with the exception of the first. The plexus is situated behind the sterno-mastoid m. and internal jugular vein, and lies in front of the scalenus medius and the levator anguli scapulæ.

The plexus gives off *superficial* and *deep* branches. The superficial branches have been already described (p. 20).

The deep branches may be divided into an internal and an external series.

INTERNAL SERIES.—1. The *phrenic* arises from the third, fourth, and fifth cervical nerves, and passes through the thorax to be distributed to the diaphragm. (For further course see p. 59.)

2. The *communicantes noni* come from the second and third cervical nerves, wind round the internal jugular vein, and join the descendens noni in front of the carotid sheath, forming the 'ansa hypoglossi.' They supply the depressor muscles of the os hyoides and larynx.

3. *Muscular* branches to the recti antici, the rectus lateralis, and longus colli muscles.

4. Branches which communicate with the pneumogastric, hypoglossal, and sympathetic nerves, and one to join the fifth cervical.

EXTERNAL SERIES.—1. One or more branches to the nervus accessorius: firstly in the sterno-mastoid, then in the occipital triangle, and lastly beneath the trapezius.

2. *Muscular* branches to supply the trapezius, levator anguli scapulæ, scalenus medius, and sterno-mastoid.

DISSECTION. The clavicle should now be sawn through the middle, and the sternal half raised with the sterno-mastoid attached, so that the bone can be replaced, to study its relation to the subjacent parts. The scalene muscles and the subclavian artery throughout its whole course must next be carefully dissected. While this is being done, the student must be careful not to injure the branches of the subclavian artery, the lymphatic duct on the right, and the thoracic duct on the left side, the nerve to the subclavius m., the phrenic nerve, the cervical and the brachial plexuses of nerves, and their small branches.

SCALENE MUSCLES. The scalene muscles, so called from their resemblance to a scalene triangle, extend from the transverse processes of the cervical vertebræ to the first and second ribs. They may be considered as intercostal muscles, since the transverse processes of the cervical vertebræ are but rudimentary ribs. Anatomists describe them as three separate muscles—an anterior, a middle, and a posterior; the anterior and middle are attached to the first rib, the posterior to the second. In plan and purpose these three muscles are one.

SCALENUS ANTICUS. The scalenus anticus *arises* from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and is *inserted* by a flat tendon into the tubercle on the *inner* border of the first rib in front of the groove for the subclavian artery.

SCALENUS MEDIUS. The scalenus medius *arises* from the posterior tubercles of the transverse processes of all the cervical vertebræ except the first, and is *inserted* into the first rib behind the scalenus anticus, extending, from the tubercle, forwards for an inch and a half.

SCALENUS POSTICUS. The scalenus posticus *arises* from the posterior tubercles of the transverse processes of the two or three lowest cervical vertebræ, and is *inserted* into the second rib between its tubercle and angle, anterior to the levator costæ.

The scalene muscles are important agents in raising the thorax, in a deep inspiration. Take a deep breath, and you can easily feel them contracting. They can bend the cervical portion of the spine, if their lower attachment be the fixed point, as in rising from the recumbent position.

The scalenus anticus is just one of those muscles about which we ought to know well all that lies in front of it, and all that lies behind it. In the front of it are, the clavicle, the subclavius, the clavicular origin of the sterno-mastoid, the omo-hyoid, the phrenic nerve, the subclavian vein, the supra-scapular and posterior scapular arteries. Behind it are the subclavian artery, the five nerves which form the brachial plexus, and the pleura; to its inner side is the internal jugular vein.

Make your finger familiar with the feel of the tubercle on the first rib, to which the scalenus anticus is attached. This tubercle is the guide to the subclavian artery, for it enables you to find the *outer edge* of the scalenus anticus, where you must look for the vessel. Is the scalenus anticus entirely concealed from view by the sterno-mastoid or not? This will depend upon the breadth of the clavicular attachment of the sterno-mastoid. As a general rule, it may be said that the scalene muscle *is* concealed by the sterno-mastoid, and that consequently, in tying the subclavian artery, it may be necessary to divide partially the clavicular origin of the muscle.

PHRENIC NERVE.

The phrenic nerve runs down in front of the scalenus anticus, from the outer to the inner border. It arises from the third, fourth, and fifth cervical nerves, but chiefly from the fourth. It enters the chest between the subclavian artery and vein, crosses in front of the internal mammary artery, and continues its course between the pericardium and pleura, in front of the root of the lung, to the diaphragm, which it supplies.

When the spinal cord is injured above the fourth cervical vertebra, the origin of the phrenic is implicated; therefore the diaphragm, as well as the other muscles of inspiration, are paralysed. Death is the immediate result.*

* The phrenic nerve is joined by a filament from the sympathetic, and frequently

Course and Relations of the Subclavian Arteries.

The left subclavian artery differs from the right, not only in its origin, but in the relations of the first part of its course. The right should, therefore, be examined first, and then the differences between it and the left.

Right Subclavian Artery. The right subclavian artery is one of the two great branches into which the arteria innominata divides behind the sterno-clavicular joint. It runs outwards behind the scalenus anticus, then inclines downwards over the first rib, at the outer border of which it takes the name of axillary. The artery describes a curve, of which the greatest convexity is between the scalene muscles. The height to which the arch ascends varies. Generally, it rises higher in women than in men, on the right side than on the left.

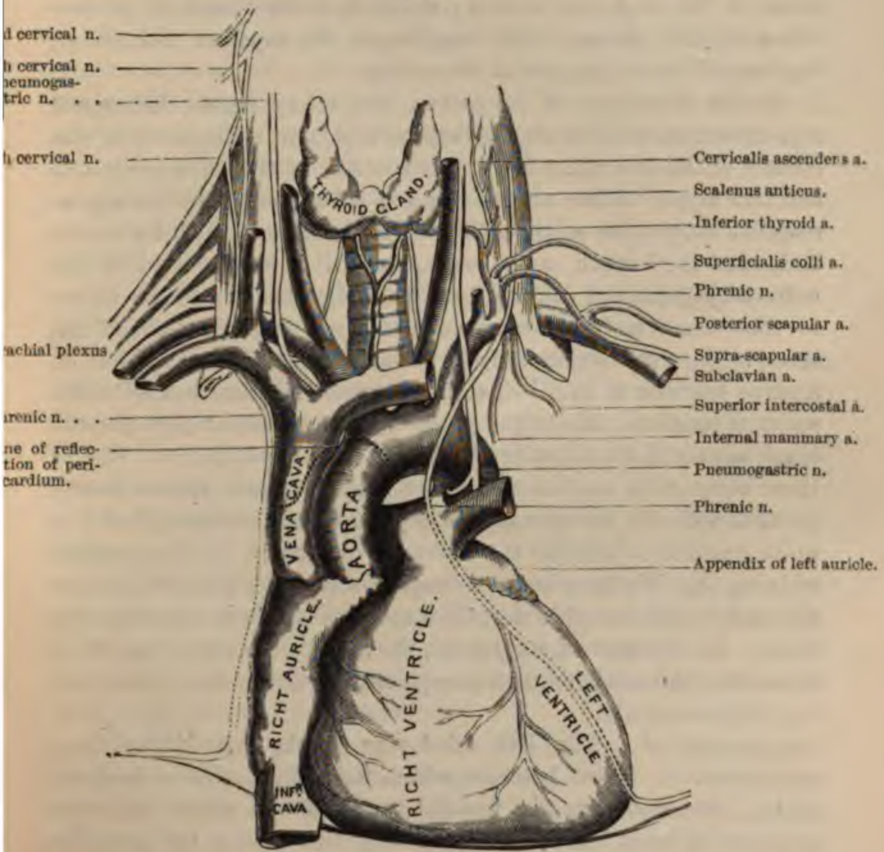
To study its relations more precisely, the course of the subclavian is divided into three parts: 1. The part which intervenes between its origin and the inner border of the scalenus anticus. 2. That which lies behind the scalenus. 3. That which intervenes between the outer border of the scalenus and the outer border of the first rib.

The *first* portion of the artery lies deeply in the neck and passes upwards and outwards to the inner border of the scalenus anticus. It is covered by the skin, platysma, superficial and deep fasciæ, the sternal end of the clavicle, the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, and a layer of deep fascia, continued from the inner border of the scalenus anticus. It is crossed by

by a filament from that branch of the brachial plexus which supplies the subclavius muscle. It is important to be aware that cases sometimes occur in which this seemingly insignificant filament is a branch of considerable size, and forms the greater portion of the phrenic itself. We have met with many instances in which this accessory branch was larger than the regular trunk; in all of them it crossed over the subclavian artery in the third part of its course, and would probably have been injured in the operation of tying this vessel. That such an accident has actually happened is recorded by Bransby Cooper in his surgical lectures. He speaks of having injured this accessory branch of the phrenic in tying the subclavian artery. The patient had incessant spasm of the diaphragm till he died.

the internal jugular and vertebral veins, by the pneumogastric and phrenic nerves, and by some cardiac filaments of the sympathetic. Inferiorly it rests upon the pleura. Behind the artery are the recurrent branch of the pneumogastric, the sympathetic

Fig. 11.



nerve, the longus colli, the transverse process of the seventh cervical vertebra and the apex of the lung covered with the pleura. Three branches arise from this portion of the subclavian—viz. the vertebral, internal mammary, and thyroid axis.

In the *second* (the highest) part of its course, the artery lies between the scalene muscles. It is covered by skin, platysma, and superficial fascia, by the clavicular origin of the sterno-mastoid, the deep cervical fascia, and by the scalenus anticus and phrenic nerve which separate it from the subclavian vein. Behind the artery is the scalenus medius; above it is the brachial plexus; below it is the pleura. Only one branch, the superior intercostal, is given off from this part of the artery.

In the *third* part of its course, the artery passes downwards and outwards, and lies in the supra-clavicular triangle upon the surface of the first rib. Here it is covered by the skin, platysma, and two layers of the cervical fascia; subsequently by the supra-scapular artery, the clavicle, the subclavius muscle, with its nerve; and, what is of much more consequence, it is here crossed by the external jugular and (often) the supra and posterior scapular veins; so that there is here a confluence of large veins in front of the artery. The subclavian vein is situated below the artery, but on a plane anterior to it. Below it is the first rib, and behind it the scalenus medius. Above the artery and to its outer side, are the trunk nerves of the brachial plexus and the omo-hyoid m. One of these nerves (the conjoined fifth and sixth cervical) runs so nearly parallel with the artery, and *on a plane anterior* to it, that it is quite possible to mistake the nerve for the artery, in the operation of tying it. We have heard a hospital surgeon of great experience say, that he had seen this mistake committed on three separate occasions. In this part of its course, the artery as a rule gives off no branches; the most frequent exceptions are the posterior scapular, and supra-scapular.

LEFT SUBCLAVIAN ARTERY. The left subclavian is the last of the three great branches which arise from the arch of the aorta. It ascends nearly vertically out of the chest, and then arches in front of the apex of the lung and pleura to reach the inner border of the scalenus anticus, behind which it runs over the first rib.

In the first part of its course, the left subclavian lies deeply in the chest, near the spine. On its left side it is covered by the

pleura; on its right side are the thoracic duct, the œsophagus and the trachea; in front are the pneumogastric and phrenic nerves, the cardiac branches of the sympathetic, the left common carotid, and the left lung covered with its pleura; the left brachio-cephalic vein crosses in front of it. Behind it is the longus colli muscle, and the inferior cervical ganglion.

At the level of the upper part of the chest, the left subclavian arches, like the right, over the apex of the lung, and has similar relations—namely, in front, it is covered by the sternal end of the clavicle, the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, and by the internal jugular and vertebral veins.

Behind the scalenus anticus, and on the surface of the first rib, the relations of the left subclavian are similar to those of the right (p. 62).

The left subclavian, then, differs from the right only in the first part of its course. Now, what are these differences? X

1. The left subclavian comes direct from the arch of the aorta, and is therefore longer, deeper in the chest, and more vertical than the right, which comes from the arteria innominata.

2. The left subclavian is in close relation with the œsophagus and the thoracic duct: the right is not.

3. The left subclavian is crossed by the left brachio-cephalic vein.

4. The left subclavian has the phrenic, pneumogastric, and sympathetic nerves nearly parallel with it; on the right side, these nerves cross the artery at a nearly right angle.

5. The left subclavian is not embraced by the recurrent laryngeal nerve, like the right subclavian.

The thoracic duct bears an important relation to the left subclavian. It ascends from the chest to the left of the œsophagus and *behind* the artery; then arching behind the internal jugular vein as high as the seventh cervical vertebra, it curves downwards and forwards to terminate in the subclavian vein at its junction with the jugular. The duct is so thin and transparent that it easily escapes observation; it is most readily found by raising the subclavian vein near its junction with the jugular, and searching

with the handle of the scalpel on the inner side of the scalenus anticus, in front of the vertebral vein.

Before tracing the branches of the subclavian artery, consider some points relating to the operation of tying it.

To tie the artery in the first part of its course, namely, on the inner edge of the scalenus anticus, is an operation of great difficulty and danger, even with the parts in a normal position. The great depth at which the artery is placed, the size and close proximity of its numerous branches, the large veins by which it is covered, its connection with the pneumogastric, recurrent laryngeal, phrenic, and sympathetic nerves, and, above all, its close contiguity with the pleura, form a combination of circumstances so formidable that one cannot be surprised the operation has never been performed with a favourable result.

In the second part of its course, between the scalene muscles, the artery is more accessible, although it is rarely ligatured in this situation. It would be necessary to divide the clavicular origin of the sterno-mastoid, the cervical fascia, and the scalenus anticus, to reach the vessel; the phrenic nerve and the subclavian vein would be the chief objects exposed to injury. This operation was performed first and with success by Dupuytren in the year 1819. More recently it has been performed by Dr. Warren, of Boston. The patient recovered, though the pleura was wounded.*

But in the last part of its course, that is, on the outer side of the scalenus, the artery may be tied with comparative facility. The incision should be made from three to four inches in length, parallel with the upper border of the clavicle. We divide the platysma, some of the supra-clavicular nerves, and the cervical fascia. The external jugular vein must be drawn to the outer side, or divided and tied at both ends. With the finger and the handle of the scalpel we then make our way down to the outer edge of the scalenus anticus, behind which the artery will be found lying upon the first rib. Remember the tubercle on the inner edge of the rib which indicates the insertion of the scalenus: this

* 'Med. Chirurg. Trans.,' vol. xxix. p. 25.

tubercle is the best guide to the artery. It is necessary to divide a layer of fascia which immediately covers the vessel before the needle can be introduced around it. Mr. Ramsden, of St. Bartholomew's Hospital, was the first who tied the subclavian in the third part of its course, in the year 1809; since that time the operation has been repeatedly performed, with very favourable results.

In the hands of a surgeon possessed of a practical knowledge of anatomy the operation is easy, provided all circumstances be favourable; but circumstances are often very unfavourable. It often happens that the aneurysmal or other tumour, on account of which the operation is performed, raises the clavicle beyond its natural level, and so disturbs the parts, that to expose the artery and place a ligature around it becomes exceedingly difficult. Under such circumstances one cannot be surprised that even distinguished anatomists have committed mistakes. Sir Astley Cooper * failed in one instance. Dupuytren perforated the artery with the point of the needle, and included one of the nerves in the ligature: fatal hæmorrhage was the result.† We were present at an operation in which the large nerve (a branch of the brachial plexus) which runs parallel with and on a plane anterior to the artery was mistaken for it and tied; the surgeon being deceived by the pulsation communicated to the nerve.

BRANCHES OF THE SUBCLAVIAN ARTERY.

The branches of the subclavian extend so widely, that in the present dissection we can trace them only for a short distance. They are four in number:

1. The vertebral.
2. The thyroid axis, a short thick trunk which gives off the inferior thyroid, supra-scapular, and posterior scapular.
3. The internal mammary.
4. The superior intercostal, which gives off the deep cervical.

As a rule, the vertebral, the thyroid axis, and the internal mammary are given off from the subclavian in the first part of

* 'London Medical Review,' vol. ii. p. 300.

† 'Edinburgh Med. and Surg. Journal,' vol. xvi. 1820.

its course, and the superior intercostal in the second part. The most frequent deviation is, that the posterior scapular (transversalis colli) arises from the subclavian in the third part of its course.*

VERTEBRAL ARTERY. This, the first and largest branch, arises from the upper part of the subclavian. For a short distance it lies in the interval between the scalenus anticus and the longus colli. Here it enters the foramen in the transverse process of the sixth cervical vertebra, and ascends through the foramina in the transverse processes of the succeeding vertebræ. In the interval between the axis and the atlas, the artery makes a sigmoid curve, that it may not be stretched in the rotation of the head. Having traversed the foramen of the atlas, the artery curves backwards along the groove in its arch, perforates the posterior occipito-atlantoid ligament and the dura mater, then enters the skull through the foramen magnum, and unites with its fellow near the lower border of the 'pons Varolii' to form the basilar artery.

Directly after the artery is given off from the subclavian, it lies behind the internal jugular vein, and, on the left side, behind the thoracic duct. As it lies upon the groove on the neural arch of the atlas it is separated from it by the suboccipital nerve, and is situated within the suboccipital triangle.

The vertebral artery is accompanied by slender nerves from the inferior cervical ganglion of the sympathetic. These nerves communicate with the spinal nerves forming the brachial plexus.

Destined for the brain, the vertebral gives off no branches in the neck, except a few small ones to the deeply-seated muscles; it furnishes, however, *lateral spinal* branches to the spinal cord and its membranes which pass through the intervertebral foramina.

* With reference to the origin of the posterior scapular (transversalis colli) artery, we made special observations during the winter session of 1858-59. We found that this artery was given off most frequently, not by the thyroid axis, but by the subclavian in the *third* part of its course. Under these circumstances the superficialis colli a. generally came from the thyroid axis.

The cranial branches of the vertebral artery are mentioned at length in the description of the arteries of the brain.

The *vertebral vein* is formed by small branches from the muscles near the foramen magnum. It descends in front of the artery through the foramina in the transverse processes, and emerging through the transverse process of the sixth, joins the brachio-cephalic vein. It receives the veins from the cervical portion of the spinal cord. In some subjects it communicates with the lateral sinus by a branch through the posterior condyloid foramen.

The cervical nerves pass through the intervertebral foramina behind the vertebral artery, so that the artery runs behind its vein, and in front of the nerves.

THYROID AXIS. The *thyroid axis* arises from the subclavian near the inner edge of the scalenus anticus, and after a course of a quarter of an inch divides into three branches, which take different directions; namely, the inferior thyroid, the supra-scapular, and the posterior scapular.

1. The *inferior thyroid* artery ascends tortuously behind the sheath of the common carotid and the sympathetic nerve, to the deep surface of the thyroid body, in which it communicates freely with the superior thyroid and with its fellow. Besides small branches to the trachea, the œsophagus, and the larynx, it gives off—

(*a*) the *ascending cervical* artery which runs up close to the spine, between the scalenus anticus and the rectus capitis anticus major, and terminates in small branches, some of which supply these muscles; others enter the intervertebral foramina, and supply the spinal cord and its membranes.

2. The *supra-scapular* artery (transversalis humeri) runs outwards over the scalenus anticus, then directly *beneath* and parallel with the clavicle: crossing over the third part of the subclavian artery, it passes beneath the posterior belly of the omo-hyoid to the superior border of the scapula. Here it is covered by the trapezius, goes *above* the transverse ligament which bridges over the notch, and divides into branches, some of which ramify above, others below, the spine of this bone. It inosculates freely in the infra-spinous fossa with the dorsalis scapulæ, a branch of the

subscapular, and with the posterior scapular artery. Near the notch, it is joined by the supra-scapular nerve, which runs *through* it. The branches of this artery are numerous but small, and are as follow: the *inferior sterno-mastoid* (p. 25); the *supra-acromial*, which anastomoses with the acromio-thoracic artery; *articular* branches to the shoulder joint; the *infra-spinous*, which ramifies in the infra-spinous fossa; and the *subscapular*, which ramifies in the substance of the subscapularis muscle.

3. The *posterior scapular* (transversalis colli) artery, of which the normal origin is said to be from the thyroid axis, very frequently arises from the subclavian in the last part of its course. It is larger than the preceding artery, and runs tortuously across the side of the neck (higher than the supra-scapular), over the scalene muscles and the great nerves of the brachial plexus (sometimes between them), and disappears beneath the trapezius and the levator anguli scapulæ to reach the superior angle of the scapula. It then runs beneath the rhomboid muscles, which it supplies, down to the inferior angle of the scapula, anastomosing freely with the terminations of the supra- and sub-scapular arteries. In the space between the sterno-mastoid and trapezius, the posterior scapular gives off the *superficialis colli*. This vessel proceeds tortuously across the posterior triangle of the neck to the under surface of the trapezius, to which, with the levator anguli scapulæ, it is principally distributed.

The *superficialis colli* often comes *direct* from the thyroid axis.

The *veins* corresponding to the supra scapular and posterior scapular arteries terminate in the external jugular, sometimes in the subclavian. The inferior thyroid vein crosses in front of the common carotid artery, and joins the internal jugular.

INTERNAL MAMMARY. This artery arises from the subclavian opposite to the thyroid axis. It enters the chest behind the subclavian vein, and descends behind the cartilages of the ribs, about half an inch from the sternum. Its further progress will be examined in the dissection of the chest (p. 121). The corresponding vein most frequently terminates in the brachio-cephalic.

SUPERIOR INTERCOSTAL. This artery is given off by the subclavian behind the scalenus anticus on the right side, and to its inner side on the left, so that you must divide the muscle to see it. It enters the chest behind the pleura, to the outer side of the first

dorsal ganglion of the sympathetic. It runs over the necks of the first and second ribs, and furnishes the arteries of the two upper intercostal spaces, and a posterior branch which is distributed to the muscles of the back and the spinal cord. It usually inosculates with the first intercostal branch of the aorta. The corresponding *vein* terminates on the right side in the vena azygos; on the left in the brachiocephalic.

Fig. 12.

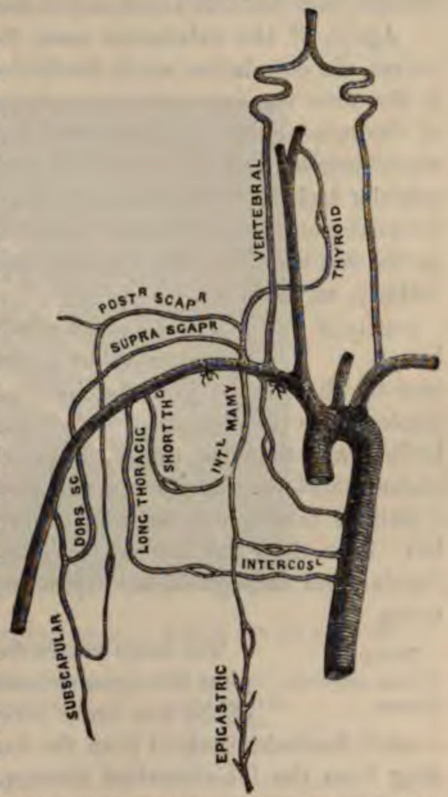


DIAGRAM TO SHOW THE INOSCULATIONS OF THE SUBCLAVIAN ARTERY.

Deep Cervical Artery. This artery arises from the superior intercostal, seldom direct from the subclavian. It goes to the back of the neck between the first rib and the transverse process of the last cervical vertebra, and ascends between the complexus and the semi-spinalis colli, both of which it supplies. It sometimes inosculates with the princeps cervicis, a branch of the occipital (p. 55).

To test your knowledge of the branches of the subclavian artery, reflect upon the answer to the following question: If the artery were tied in the *first* part of its course before it gives off any branches, how would the arm be supplied with blood? The answer is, by six collateral channels, as follow: 1. By the communications between the superior and inferior thyroid: 2. Between

the two vertebral: 3. Between the internal mammary and the intercostals and the epigastric: 4. Between the thoracic branches of the axillary, and the intercostal branches of the aorta: 5. Between the superior intercostal and the aortic intercostals. 6. Between the princeps cervicis and the deep cervical. Most of these inosculations are shown in the diagram, p. 69.

Again, if the subclavian were tied in the *third* part of its course, the circulation would be carried on by the communications: 1. Between the supra-scapular and the dorsalis scapulæ, a branch of the subscapular: 2. Between the supra-acromial branch of the supra-scapular and the acromio-thoracic: 3. Between the posterior scapular and the subscapular and dorsalis scapulæ: 4. Between the internal mammary, the aortic intercostals and superior intercostal on the one hand, and the long and short thoracic branches of the axillary, on the other.

SUBCLAVIAN VEIN. The subclavian vein does not form an arch like the artery, but proceeds in a nearly straight line over the first rib to join the internal jugular. Throughout its whole course the vein is situated on a plane anterior to and a little lower than the artery, from which it is separated by the scalenus anticus, the phrenic and pneumogastric nerves. It has a pair of valves just before its junction with the internal jugular. It receives the anterior jugular, the vertebral, the external jugular, and through it, the supra-scapular and posterior scapular veins.

BRACHIAL PLEXUS OF NERVES. The large nerves forming the plexus which supplies the upper extremity are the anterior divisions of the four lower cervical and the first dorsal, with a small fasciculus derived from the fourth cervical nerve. Emerging from the intervertebral foramina they appear between the anterior and middle scalene muscles, and pass with the subclavian artery into the axilla. To this bundle of nerves the name *plexus* is given, on account of their mutual communications. The plexus at its root is wide, and situated higher than the subclavian artery, and nearly on the same plane; but as the plexus descends beneath the clavicle, its component nerves converge, and, in the

axilla, completely surround the artery: one cord lying to the outer side, a second lying to the inner side, and a third behind the vessel.

The plexus is crossed superficially by the omo-hyoid muscle, and by the supra-scapular and posterior scapular arteries.

The arrangement of the nerves in the formation of the plexus

FIG. 13.

DIAGRAM OF THE FORMATION OF THE BRACHIAL PLEXUS AND ITS BRANCHES.

C 4–8. Anterior trunks of the cervical nerves.
D 1. Anterior trunk of the first dorsal n.
9. N. to the rhomboid m.
10. Supra-scapular.
11. N. to subclavius m.
12–13. Anterior thoracic.
14, 15, 16. Subscapular n.
17. Lesser int. cutaneous.
18. Musculo-cutaneous.
19. Circumflex.
20. Median.
21. Musculo-spiral.
22. Ulnar.
23. Int. cutaneous.
24. Ext. respiratory of Bell.

is very variable, and often not alike on both sides. The most usual arrangement is, that at the outer border of the scalenus anticus, the fifth and sixth cervical n. unite to form an upper trunk; the eighth and the first dorsal n. form a lower trunk; the

seventh cervical runs for some distance alone, and forms a middle trunk. Now each of these five primary nerves divides into an anterior and a posterior branch: the anterior branches given off from the fifth, sixth, and seventh form the *outer cord* of the plexus; the anterior branches given off from the eighth cervical and first dorsal form the *inner cord*; while the posterior branches of all the nerves (namely, the fifth, sixth, seventh, eighth cervical and first dorsal) unite to form the *posterior cord.**

The branches arising from the plexus are best arranged into those given off above the clavicle, and those given off below it. The following are those given off above the clavicle.

a. The branch forming one of the roots of the phrenic arises from the fifth cervical. (Not in the diagram.)

b. Nerve to the subclavius m.—This proceeds from the fifth and sixth cervical, and crosses the subclavian artery in the third part of its course. It frequently sends a filament, which passes in front of the subclavian vein to join the phrenic nerve.

c. Nerves to the *scaleni* and the *longus colli* muscles are given off from the lower cervical nerves as they leave the intervertebral foramina.

d. Nerve to the *rhomboid muscles.*—This arises from the fifth cervical nerve, passes through the scalenus medius, and accompanies the posterior scapular artery, beneath the levator anguli scapulæ, which, as well as the rhomboid muscles, it supplies.

e. The *supra-scapular* nerve arises from the cord formed by the fifth and sixth cervical n., runs to the upper border of the scapula, where it meets with the corresponding artery, and then passing through the notch in the scapula, terminates in the supra-spinatus and infra-spinatus m.

f. The *posterior thoracic nerve* (called *external respiratory* by Sir C. Bell) to the *serratus magnus* arises from the fifth and sixth cervical, in the substance of the scalenus medius. It passes through this muscle and subsequently emerges below the rhomboid

* For a description of the arrangement of the nerves constituting the plexus, see a paper by Lucas, 'Guy's Hospital Reports,' 1875; also Turner in the 'Journal of Anatomy,' 1872.

nerve; it then descends behind the plexus and the subclavian vessels to the outer surface of the serratus magnus, to the several digitations of which it is exclusively distributed.

g. An *articular branch* is distributed to the shoulder joint; besides some filaments to the constituent bones.

It only remains to be observed that the upper cord of the brachial plexus receives a branch from the lower cord of the cervical, and that each of its component nerves communicates by slender filaments with the sympathetic.

Below the clavicle the plexus divides into branches for the supply of the arm; namely, the anterior thoracic nerves (two in number, to the pectoralis major and minor), the subscapular (three in number, to the subscapularis, the latissimus dorsi, and teres major), the circumflex (to the deltoid and teres minor), the median, the musculo-spiral, the ulnar, the external cutaneous, the internal cutaneous, and the lesser internal cutaneous (nerve of Wrisberg): all of which will be described more fully in the dissection of the arm.

DISSECTION OF THE FACE.

Much practice is required to make a good dissection of the face. The muscles of expression are numerous and complicated; they are interwoven with the subcutaneous tissue and closely united to the skin: their fibres are often pale and indistinct. The face is largely supplied with motor and sensory nerves, of which the ramifications extend far and wide. Therefore you must not be discouraged if, in a first attempt, you fail to make a satisfactory display of the parts.

The cheeks and nostrils should be distended with horse-hair, and the lips sewn together.

Make an incision down the mesial line of the face; another from the chin along the base of the lower jaw to the angle; then prolong it, in front of the ear, to the zygoma. Reflect the skin from below upwards. Each muscle, to be properly cleaned, should be stretched by hooks.

The student is recommended to make out the muscles and arteries on the one side, leaving the other side for the display of the nerves.

The motor nerve which supplies all the muscles of expression in the face is the '*portio dura*,' or facial division of the seventh cranial nerve. It emerges from the stylo-mastoid foramen, and divides into branches, which pass through the parotid gland, forming a plexus termed the '*pes anserinus*.'

The sensory nerves of the face are chiefly derived from the three divisions of the fifth cranial nerve; namely, the supra-orbital, the infra-orbital, and the mental. The only other nerves which confer sensation upon the face are, the auriculo-parotidean branch of the cervical plexus (p. 20), which supplies the skin covering the parotid gland and part of the cheek; and the naso-lobular, which supplies the ala and tip of the nose.

It is convenient to arrange the muscles of the face under three groups; appertaining, respectively, to the mouth, the nose, the eyebrows and lids. Begin with those of the mouth.

The muscles of the mouth are arranged thus: there is an orbicular or sphincter muscle surrounding the lips; from this, as from a common centre, muscles diverge and are fixed into the surrounding bones. They are named elevators, depressors, sphincters, &c., according to their respective action.

MUSCULUS RISORIUS (SANTORINI). This muscle arises from the fascia over the masseter m., and passes horizontally forwards to be inserted into the angle of the mouth, where it intermingles with the orbicularis oris and other muscles in this situation. It produces the smile, not of good humour, but of derision. This muscle is usually considered as a part of the platysma myoides (p. 17).

ORBICULARIS ORIS. This muscle, nearly an inch in breadth, surrounds the mouth, forming a kind of sphincter. Its size and thickness in different individuals produce the variety in the prominence of the lips. Observe that its fibres, except the most internal, do not surround the mouth in one unbroken series, but that those of the upper and lower lip decussate at the angles of the mouth, and intermingle with the fibres of the buccinator and

other muscles which converge from different parts of the face.* The cutaneous surface of the muscle is intimately connected with the lips and the surrounding skin; the deep surface is separated from the mucous membrane by the labial glands and the coronary vessels.

The orbicularis is the antagonist of all the muscles which move the lips. Upon a nice balance of their opposite actions depends the play and infinitely varied expression of the mouth.†

DEPRESSOR ANGULI ORIS. This muscle *arises* broadly from the oblique line of the lower jaw behind the foramen mentale, and is *inserted* narrowly into the angle of the mouth, intermingling with the zygomatic muscles. It is an important muscle in the expression of sorrowful emotions. We see its action when children cry.

DEPRESSOR LABII INFERIORIS, OR QUADRATUS MENTI. This muscle *arises* from the oblique line of the lower jaw below the foramen mentale, and is *inserted* into the lower lip. It covers the vessels and nerves which emerge from the foramen.

LEVATOR MENTI OR LEVATOR LABII INFERIORIS. This muscle *arises* from the lower jaw, from the fossa below the incisor teeth, and, passing down, is *inserted* into the skin of the chin. To see it, evert the lower lip and remove the mucous membrane on either side of the frænum. There are two of them, one for each side. Their action is well seen when we shave the chin, or protrude the lower lip.

* The orbicularis consists of two parts, an inner or *labial* part, and an outer or *facial*; the difference in appearance of the fibres being very marked. The *labial* part consists of pale thin fibres, forming more or less of the inner part of the orbicularis, and has no attachment to bone; the *facial* part is thinner but broader, and besides being connected with other muscles, is attached to bone thus:—in the upper lip by two fasciculi on each side, one to the septum nasi, the other to the alveolar border opposite the incisor teeth; in the lower lip by a single fasciculus to the lower jaw on each side opposite the canine tooth.

† In strong muscular lips the upper part of the orbicularis sends a small subcutaneous slip of muscle from each side along the septum nasi nearly to the apex. The interval between the two slips corresponds to the furrow which leads from the nose to the lip. This is the *naso-labialis* or *depressor septi narium* of Haller and Albinus.

ZYGOMATICUS MAJOR AND MINOR. The Z. major *arises* from the outer surface of the malar bone close to its suture with the zygoma, passes obliquely downwards and inwards, and is *inserted* into the angle of the mouth, joining the depressor anguli oris. The Z. minor *arises* from the outer surface of the malar bone, in front of the preceding, and is *inserted* into the outer border of the levator labii superioris near the corner of the mouth. The zygomaticus minor is often absent. The zygomaticus major is the muscle of laughing: the minor expresses sadness.

Before examining the orbicularis palpebarum, notice the tendo oculi. To make the tendon more apparent, the tarsal cartilages should be drawn outwards.

TENDO OCULI OR PALPEBRARUM. This tendon is a thin cord about two lines * in length, and is readily felt at the inner angle of the eye by drawing the eyelids outwards. It is fixed to the nasal process of the superior maxillary bone, in front of the lachrymal groove, passes horizontally outwards, and divides into two diverging portions, one of which is attached to the upper, the other to the lower tarsal cartilage. The tendon crosses the lachrymal sac a little above the centre, and furnishes a tendinous expansion which covers the sac and is attached to the margin of the bony groove which contains it. To see this expansion we must reflect that portion of the orbicularis palpebrarum which covers the sac.

In puncturing the lachrymal sac the knife is introduced below the tendon, in a direction downwards, outwards, and a little backwards. We have to divide the skin, a few fibres of the orbicularis, and the fibrous expansion from the tendo palpebrarum. The angular artery and vein are situated on the inner side of the incision.

ORBICULARIS PALPEBRARUM. This thin broad muscle surrounds the margin of the orbit and the eyelids, forming a sphincter. It is attached on the inner side to the tendo palpebrarum, to the nasal process of the superior maxillary bone, to the internal angular process of the frontal bone, and to the lower margin of the orbit.

* A line is the twelfth part of an inch.

From this attachment the fibres form a series of oval curves, taking a wide sweep, and pass uninterruptedly round the eyelids and orbit.

The fibres which belong to the eyelids (orbicularis palpebrarum) are thin and pale, and form, over each eyelid, a series of elliptical curves which meet at the external canthus of the lids, and are loosely attached to the external tarsal ligament. The degree of their curvature becomes less as they approach the margin of the lids, so that some fibres proceed close to the lashes. This was first pointed out by Riolanus,* and described as the *musculus ciliaris*.† The fibres which spread over the orbital margins are thicker and redder, and mingle, on the forehead, with the occipito-frontalis and corrugator supercilii, on the cheek, with the elevators of the upper lip and nose and the zygomaticus minor.

No fat is found on the eyelids; nothing intervenes between the skin and the muscle but loose connective tissue, that there may be no impediment to the free play of the lids.

The orbicular muscle not only closes the eyelids but protects the eye. When the eye is threatened, the muscle suddenly contracts, presses the eye back into the orbit, and contracts the skin of the brow and cheek so as to form a soft cushion in front of it. The cushion itself may be severely bruised, as is seen in a 'black eye;' but the globe itself is rarely injured. When the eye is closed, as in winking, the palpebral portion of the muscle contracts. Observe this movement, and notice that the lids are drawn slightly inwards as well as closed. The object of this inward motion is to direct the tears towards the inner angle of the eyelids, where they are absorbed by the puncta lachrymalia.

Since the orbicular muscle is supplied by the facial nerve, it is affected in facial palsy, and the patient cannot close the lids.

CORRUGATOR SUPERCILII. This *arises* from the inner end of the superciliary ridge of the frontal bone, and is *inserted* into the under surface of the orbicularis palpebrarum and occipito-

* 'Anthropologia,' lib. v. cap. 10.

† Strictly speaking, the musculus ciliaris arises from the two little divisions of the tendo oculi, and is inserted, at the external canthus, into the fibrous tissue which unites the two tarsal cartilages.

frontalis. It lies concealed beneath these two muscles, and is the proper muscle of frowning. Its nerve comes from the facial.

The present being a good opportunity to examine the structure and appendages of the eyelids, postpone for the present the dissection of the remaining muscles of the face.

The eyelids are two elliptical movable folds, consisting of strata of different tissues. The upper lid is the larger, and more movable, so that when the eye is closed, it is mainly by this fold. The interval between the two lids is called the '*fissura palpebrarum*,' which terminates on the inner and outer sides, in two angles, the *canthi*. The lids are thickest at their borders, are somewhat curved, and near the inner canthus each presents a slight elevation, the *papilla lachrymalis*, at the top of which is a small opening, *punctum lachrymale*, to receive the tears.

CARUNCULA LACHRYMALIS. The conjunctiva lines the inner surface of the lids, and at the inner canthus is raised into a red rounded eminence, called the *caruncula lachrymalis*. This is composed of an aggregation of sebaceous glands covered with mucous membrane. On the surface of it are minute hairs. Its use is, probably, to support the inner junction of the lids. When the caruncle is diminished in size by disease, the puncta lachrymalia become displaced, and the tears run down the cheek.

External to the caruncula lachrymalis is a slight vertical fold of conjunctiva, *plica semilunaris*, which is by some considered to be a rudimentary membrana nictitans (the third eyelid found in birds).

The conjunctival coat of the eyelid will be described with the anatomy of the eye. Observe at present, that it is more vascular than the conjunctival coat of the eye, and that it presents a number of minute papillæ, which, when enlarged and aggregated by inflammation, give rise to the disease called 'granular lids.'

The *eyelashes* (cilia) are placed in two or more rows along the edges of the tarsal cartilages. The eyelashes of the upper lid are longer and more numerous than in the lower; and their convexity is directed downwards, while those of the lower lid present an opposite curve. The bulbs of the lashes are situated between the

tarsal cartilage and the fibres of the orbicularis palpebrarum. They are supplied with blood by the palpebral branches of the ophthalmic artery which run parallel and close to the free borders of the lids beneath the orbicular muscle.

Structure of the eyelids. The eyelids are composed of different tissues, arranged in successive strata one beneath the other. They are—1. The skin: 2. The orbicularis palpebrarum: 3. The tarsal cartilage, and the palpebral ligament which extends from the margin of the orbit to the outer surface of the cartilage: 4. The expanded tendon of the levator palpebræ (in the upper lid only): 5. Meibomian glands: 6. Mucous membrane. These structures are severally connected by areolar tissue, which never contains fat.

Such, in outline, is the structure of the eyelids. Their use is best described by Socrates, who, in answer to the question whether animals were made by chance or design, replies: 'Think you not that it looks like the work of *forethought*, because the sight is delicate, to guard it with eyelids as with shutters, which open when we want to see, and shut during sleep; and, that even winds may not hurt them, to make eyelashes in the lids for a sieve; and to furnish the parts over the eyes with eyebrows, as with eaves, so that even the sweat from off the head may do them no mischief?' *

The *skin* of the eyelids is remarkably smooth and delicate. It is abundantly supplied with sensory nerves by branches of the fifth pair—namely, by the supra-orbital, supra-trochlear, infra-trochlear, lachrymal, and infra-orbital nerves.

The *orbicularis palpebrarum* has been already described (p. 76). It is supplied with nerves by the facial.

The *levator palpebræ* arises from the back of the orbit, gradually becomes broader, and terminates in a thin aponeurosis, which

* Xenophon's Memorabilia, b. 1. c. iv. § 6: οὐ δοκεῖ σοι καὶ τόδε προνοίας ἔργον ἐοικέναι, τό, ἐπεὶ ἀσθενὴς μέν ἐστιν ἡ ὄψις, βλεφάροις αὐτὴν θυρῶσαι, ἃ, ὅταν μὲν αὐτῇ χρῆσθαί τι δέῃ, ἀναπετάννυται, ἐν δὲ τῷ ὕπνῳ συγκλείεται; ὡς δ' ἂν μηδὲ ἄνεμοι βλάπτωσιν, ἠθμὸν βλεφαρίδας ἐμφῦσαι· ὀφρύσι τε ἀπογεισῶσαι τὰ ὑπὲρ τῶν ὀμμάτων, ὡς μηδ' ὁ ἐκ τῆς κεφαλῆς ἱδρὼς κακουργῇ.

unites with the broad tarsal ligament, and is lost on the upper surface of the superior tarsal cartilage.

TARSAL CARTILAGES AND LIGAMENTS. These are plates of dense fibro-cartilage which support and give shape to the eyelids. There is one for each lid, and they are connected at the angles (*commissures* or *canthi*) of the lids through the medium of fibrous tissue. They can be best examined by everting the lids. Each cartilage resembles its lid in form. The upper is the larger, is broad in the middle, and gradually becomes narrower at either end. The lower is nearly of uniform breadth throughout. Both are thicker on the nasal than the temporal side. They are connected to the margin of the orbit, and maintained in position by the tendo palpebrarum (p. 76), and by what are called the *broad tarsal* or *palpebral ligaments*: these ligaments are continuations from the periosteum of the orbit to the tarsal cartilages, and are denser at the outer part of the orbit. There are two of them, termed upper and lower, and proceeding to each cartilage respectively. When an abscess forms in the connective tissue of the lids, these ligaments prevent the matter from making its way into the orbit.

Each tarsal cartilage is moreover attached to the malar bone by means of a ligament, called the *external tarsal ligament.*

The ciliary margin is the thickest part of the tarsal cartilages. It is generally stated that the inner edge of each is sloped or bevelled off; and that, when the lids are closed, there is formed, with the globe of the eye, a triangular channel. This channel is said to conduct the tears to the puncta lachrymalia. According to our observation, this channel does not exist; for when the lids are closed, their margins are in such accurate apposition, that not the slightest interspace can be discovered between them.

X PUNCTA LACHRYMALIA. The *puncta lachrymalia* are two pin-hole apertures, easily discovered on the margin of the lids, close to the inner angle. They are the orifices of the canals, called *canaliculi*, which pass inwards, and convey the tears into the lachrymal sac. Observe that their orifices are directed backwards. The upper canaliculus, the longer and narrower of the two, ascends

for a short distance nearly vertically, and then dilating into a small pouch makes a sharp bend inwards for about a quarter of an inch to join the lachrymal sac; the lower canal descends perpendicularly, and, like the upper, makes a sharp bend, after which it pursues a direction upwards and inwards to the sac. The two canals open separately into the sac (sometimes by a common orifice). In facial palsy, the tensor tarsi being affected, the puncta lose their proper direction, and the tears flow over the cheek.

Fig. 14.

In the introduction of probes for the purpose of opening the contracted puncta, or of slitting up the lachrymal ducts, it is necessary to know the exact direction of these canals. (*See* diagram.) When from any cause the tears are secreted in greater quantity than usual, they overflow and trickle down the cheek

MEIBOMIAN GLANDS. These compound sebaceous glands, so called after the anatomist* who first described them, are situated on the under surface of each of the tarsal cartilages. In the upper lid there are between twenty and thirty; not quite so many in the lower. On everting the lid, they are seen running in longitudinal rows in grooves of the cartilage. Under the microscope, they are seen to consist of a straight central tube, round the sides of which are a number of openings leading to short cæcal dilatations. The orifices of these glands are situated on the free margin of the lids behind the lashes. They are lined with flattened epithelial cells which, in the cæcal dilatations, become cubical. Their function is to secrete a sebaceous material, which prevents the lids from sticking together.

Let us now examine the muscles in connection with the nose: namely—the pyramidalis nasi, the compressor naris or alæ nasi, and the depressor alæ nasi. All are supplied by the facial nerve.

* H. Meibom, 'De vasis palpebrarum novis.' Helmstedt, 1666.

PYRAMIDALIS NASI. This is situated on the bridge of the nose, one on each side of the mesial line, and is usually regarded as a continuation of the occipito-frontalis (p. 2). The two muscles diverge as they descend, and their fibres blend with those of the compressor naris. Their action produces transverse wrinkles of the skin at the root of the nose, as in the expression of an aggressive feeling.

COMPRESSOR NARIS. This muscle is triangular, and *arises* by its apex from the canine fossa of the superior maxilla, and is *attached* to a broad thin aponeurosis which spreads over the dorsum of the nose, and joins its fellow. The origin of this muscle is concealed by the levator labii superioris alæque nasi.

When the preceding muscle is reflected from its junction with its fellow, a small nerve is seen running down towards the tip of the nose. This nerve is the *superficial branch* of the nasal nerve (called also *naso-lobular*). It becomes subcutaneous between the nasal bone and the cartilage, and supplies the tip and lobule of the nose. It is joined by a branch of the facial nerve at its termination.

DEPRESSOR ALÆ NASI. This *arises* from the superior maxilla, above the second incisor tooth, and is *inserted* into the septum and ala of the nose. It is situated between the mucous membrane and the muscular structure of the upper lip; so that, to expose it, the upper lip must be everted, and the mucous membrane removed.

Besides the muscles above described, we find in connection with the cartilages of the alæ of the nose, pale muscular fibres which have no very definite arrangement and require a lens for their detection. Some anatomists describe a '*dilatator naris posterior*' as arising from the nasal process of the superior maxilla and the sesamoid cartilages, and inserted into the skin of the margin of the nostril; also a *dilatator naris anterior*, which descends vertically from the cartilage of the aperture to its free margin. The action of these diminutive muscles is to raise and evert the ala of the nose, and to counteract its tendency to be closed by atmo-

spheric pressure. In dyspnœa, and in certain mental emotions, they contract with great energy.

LEVATOR LABII SUPERIORIS ALÆQUE NASI. This *arises* from the nasal process of the superior maxillary bone near its orbital margin, and passing downwards divides into two portions: an inner, *inserted* into the side of the ala of the nose; an outer, into the upper lip, where its fibres blend with the orbicularis oris and levator labii superioris. It acts chiefly in expressing the smile of derision. Its habitual use occasions the deep furrow which, in most faces, runs from the ala of the nose towards the corner of the mouth.

LEVATOR LABII SUPERIORIS PROPRIUS. This *arises* from the lower margin of the orbit, i.e. from the superior maxilla and malar bone, above the infra-orbital foramen, and is *inserted* into the upper lip, where its fibres blend with the orbicularis oris. It is nearly an inch in breadth at its origin, which covers the infra-orbital vessels and nerves, and is itself overlapped by the orbicularis palpebrarum.

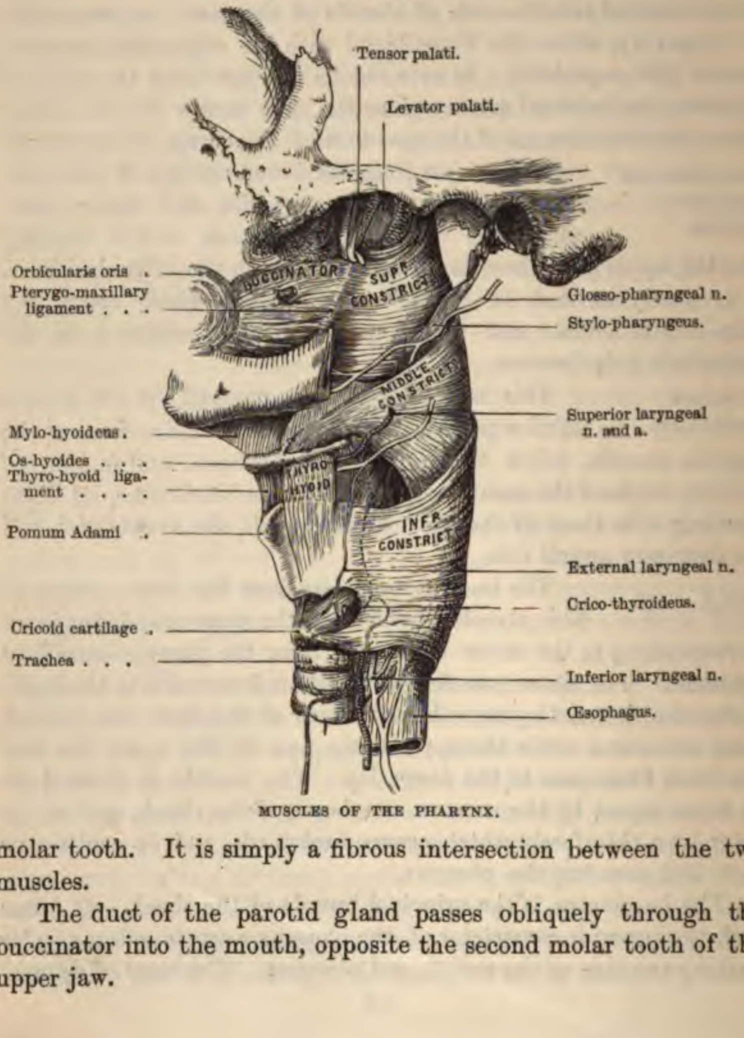
LEVATOR ANGULI ORIS. This muscle, which is covered by the levator labii superioris, *arises* from the canine fossa of the superior maxilla, below the infra-orbital foramen, and is *inserted* into the angle of the mouth, superficial to the buccinator, its fibres blending with those of the the orbicularis oris, the zygomatici, and the depressor anguli oris.

BUCCINATOR. The buccinator *arises* from the outer surface of the alveolar borders of the upper and lower jaws, corresponding to the molar teeth, and from the pterygo-maxillary ligament. The fibres pass forwards and are inserted into the angle of the mouth and the muscular structure of the lips; the central fibres decussate, while the upper fibres pass to the upper lip, and the lower fibres pass to the lower lip. The muscle is covered on its inner aspect by the mucous membrane of the cheek, and on its outer by a thin fascia which passes backwards, and is continuous with that covering the pharynx.

The buccinator is the principal muscle of the cheek. It forms with the superior constrictor of the pharynx a continuous muscular wall for the side of the mouth and pharynx. The bond of connec-

tion between the buccinator and the superior constrictor is the *pterygo-maxillary ligament.* Now this ligament (*see* diagram) extends from the hamular process vertically to the posterior extremity of the mylo-hyoid ridge of the lower jaw near the last

FIG. 15.



MUSCLES OF THE PHARYNX.

molar tooth. It is simply a fibrous intersection between the two muscles.

The duct of the parotid gland passes obliquely through the buccinator into the mouth, opposite the second molar tooth of the upper jaw.

The chief use of the buccinator is to keep the food between the teeth during mastication. It can also widen the mouth. Its power of expelling air from the mouth, as in whistling or playing on a wind instrument, has given rise to its peculiar name. It is supplied by the facial nerve, and is, therefore, affected in facial paralysis.

BUCCAL FASCIA. The buccinator muscle is covered by a thin layer of fascia, which adheres closely to its surface, and is attached to the alveolar border of the upper and lower jaw. This structure is thin over the anterior part of the muscle, but more dense behind, where it is continuous with the aponeurosis of the pharynx. It is called the *bucco-pharyngeal fascia*, since it supports and strengthens the muscular walls of these cavities. In consequence of the density of this fascia, abscesses do not readily burst into the mouth or the pharynx.

BUCCAL AND MOLAR GLANDS. The *buccal* glands, in structure compound racemose like the salivary, are situated between the buccinator and the mucous membrane. They resemble the labial glands found beneath the mucous membrane of the lips, though somewhat smaller. Three or four other glands, about the size of a little split pea, should be made out, as they lie between the masseter and buccinator; these are the *molar* glands. Their secretion, said to be mucous, is conveyed to the mouth by separate ducts near the last molar teeth.

Between the buccinator and the masseter, there is, in almost all subjects, an accumulation of fat. It is found, beneath the zygoma especially, in large round masses, and may be turned out with the handle of the scalpel. It helps to fill up the zygomatic fossa, and being soft and elastic, presents no obstacle to the free movements of the jaw. Its absorption in emaciated individuals occasions the sinking of the cheek.

FACIAL ARTERY. The facial (external maxillary) artery is the third branch of the external carotid. It runs tortuously beneath the hypoglossal nerve, the posterior belly of the digastricus and the stylo-hyoideus, next *through* or under the substance of the submaxillary gland, and mounts over the base of

the jaw at the *anterior edge of the masseter* muscle. Up to this point we traced it in the dissection of the neck (page 45). It now ascends tortuously near the corner of the mouth and the ala of the nose, towards the inner angle of the eye, where, much diminished in size, it inosculates with the terminal branch of the ophthalmic, a branch of the internal carotid. In the first part of its course on the face, the artery is covered only by the platysma; above the corner of the mouth it is crossed by a few fibres of the orbicularis oris and the zygomatici; still higher it is covered by some of the fibres of the elevators of the upper lip and the nose. It lies successively upon the buccinator, levator anguli oris, and levator labii superioris muscles. In its course along the face it gives off the following branches:

a. The *inferior labial* artery passes inwards under the depressor anguli oris and inosculates with the mental branch of the inferior dental, the inferior coronary, and the submental arteries.

b. The *inferior coronary* artery comes off near the angle of the mouth, either directly from the facial, or in common with the superior coronary. It runs tortuously along the lower lip, beneath the depressor anguli oris; it then pierces the orbicularis, running between this muscle and the mucous membrane of the lip. It inosculates largely with its fellow, the inferior labial and the mental arteries.

c. The *superior coronary* proceeds along the upper lip close to the mucous membrane, and inosculates with its fellow; thus is formed round the mouth a complete **arterial circle,** which can be felt pulsating on the inner side of the lip, near the free border. From this circle numerous branches pass off to the papillæ of the lips, and the labial glands. The superior coronary gives off a branch, *the artery of the septum,* which ascends along the septum to the apex of the nose; also a small one to the ala nasi.

d. The *lateral artery of the nose,* a branch of considerable size, arises opposite the ala nasi beneath the levator labii superioris alæque nasi, ramifies upon the external surface of the nose, and inosculates with the nasal branch of the ophthalmic artery, the infra-orbital, and the artery of the septum.

e. The *angular artery,* which may be regarded as the termination of the facial, inosculates on the inner side of the tendo palpebrarum with the nasal branch of the ophthalmic artery.

The facial artery supplies numerous branches to the muscles of the face, and inosculates with the transversalis faciei, infra-orbital, the mental, the sublingual branch of the lingual, the nasal branches of the internal maxillary, the buccal, and the ophthalmic arteries.

The facial artery and its branches are surrounded by a minute plexus of nerves (nervi molles), invisible to the naked eye. They are derived from the superior cervical ganglion of the sympathetic, and exert a powerful influence over the contraction and dilatation of the capillary vessels, and thus occasion those sudden changes in the countenance indicative of certain mental emotions, e.g. blushing or sudden paleness.*

The *facial vein* does not run with the artery, but takes a straight course from the inner angle of the eye to the anterior border of the masseter. In this course it descends upon the levator labii superioris, then passes beneath the zygomatic muscles, over the termination of the parotid duct, and at the anterior border of the masseter passes over the jaw, behind the facial artery, and joins the internal jugular.

The facial vein is a continuation of the frontal, which descends over the forehead, and, after receiving the supra-orbital, takes the name of 'angular' at the corner of the eye. It communicates with the ophthalmic vein, receives the veins of the eyelids, the external parts of the nose, the coronary veins, and others from the muscles of the face. Near the angle of the mouth it is increased in size by a communicating branch from the infra-orbital vein, and by a large vein which comes from a venous plexus—*pterygoid plexus*—deeply seated behind the superior maxillary bone. The other veins which empty themselves into the facial correspond with the branches given off from the facial artery.

ARTERIA TRANSVERSALIS FACIEI. This artery arises from the temporal or the external carotid in the substance of the parotid gland. It runs forwards across the masseter

* MM. Bernard and Brown-Séquard have proved by experiment that if the branches of the sympathetic, which accompany the facial artery, be divided, the capillary vessels of the face, being deprived of their contractile power, become immediately distended with blood, and the temperature of the face is raised.

between the parotid duct and the zygoma, and is distributed to the glandula socia parotidis, and the masseter. It anastomoses with the infra-orbital and facial. It is seldom of large size, except when it supplies those parts which usually receive blood from the facial. We have seen it as large as a goose-quill, furnishing the coronary and the nasal arteries; the facial itself not being larger than a sewing thread.

The parotid gland is now to be examined. Its boundaries, its deep relations, the course of its duct, and the objects contained within the gland, must be carefully observed.

PAROTID GLAND. The parotid, the largest of the salivary glands, occupies the space between the ramus of the jaw and the mastoid process. It is bounded above by the zygoma; below, by the sterno-mastoid and digastric muscles; behind, by the meatus auditorius externus and the mastoid process; in front, it lies over the ascending ramus of the jaw, and is prolonged for some distance over the masseter. It is separated from the submaxillary gland by the stylo-maxillary ligament; sometimes the two glands are directly continuous.

The superficial surface of the gland is flat, and covered by a strong layer of fascia, a continuation of the cervical. It not only surrounds the gland, but sends down numerous partitions which form a framework for its lobes. The density of this sheath explains the pain caused by inflammation of the gland, the tardiness with which abscesses within it make their way to the surface, and the propriety of an early opening.

The deep surface of the gland is irregular, and moulded upon the subjacent parts. Thus, it passes inwards between the neck of the jaw and the internal lateral ligament; it extends upwards and occupies the posterior part of the glenoid cavity; below, it reaches the styloid process, and sometimes penetrates deep enough to be in contact with the internal jugular vein.

That portion of the gland which lies on the masseter muscle is called *glandula socia parotidis*. It varies in size in different subjects; and is situated chiefly above the parotid duct, into which it pours its secretion by one or two smaller ducts.

The *duct* of the parotid gland (ductus Stenonis*), about two inches long, is very thick and strong. In this respect it differs from the duct of the submaxillary gland, which is less exposed to injury. It runs transversely forwards over the masseter, about an inch below the zygoma, through the fat of the cheek, then perforates the buccinator obliquely, and opens into the mouth opposite the second molar tooth of the upper jaw. Near its termination it is crossed by the zygomaticus major and the facial vein. After perforating the buccinator, the duct passes for a short distance between the muscle and the mucous membrane. Its orifice is small and contracted compared with the diameter of the rest of the duct, which will admit a crow-quill; it is not easily found in the mouth, being concealed by a fold of mucous membrane.

The direction of the parotid duct corresponds with a line drawn from the middle of the lobule of the ear to a point midway between the nose and the mouth.

On carefully removing the substance of the parotid gland, the following structures are seen in its interior, proceeding in the order of their depth from the surface:

1. Two or more small lymphatic glands.
2. The pes anserinus, or primary branches of the facial nerve.
3. Branches from the auriculo-parotidean and temporo-auricular nerves which communicate in its substance with the facial nerve.
4. The external jugular vein formed by the junction of the internal maxillary and temporal veins.
5. The external carotid artery, which, after distributing many branches to the gland, divides, opposite the neck of the jaw, into the internal maxillary and temporal; the latter giving off in the gland the auricular and transverse facial arteries.†

* Nic. Steno, 'De glandulis oris,' etc. Ludg. Bat. 1661.

† Reviewing the intimate and deep connections of the parotid gland, one cannot but conclude that it is almost impracticable to remove it entirely during life. If this conclusion be correct, even in the normal condition of the gland, what must it be when

The *lymphatic* glands about the parotid deserve notice, since they are liable to become enlarged, and simulate disease of the parotid itself. A lymphatic gland lies close to the root of the zygoma, in front of the cartilage of the ear; this gland is sometimes affected in disease of the external tunics of the eye; e.g. in purulent ophthalmia: also in affections of the scalp.

The parotid belongs to the compound racemose form of glands. Tracing its main duct into the substance of the gland, we find that it divides into smaller ones, which again subdivide into the small ramuscules which terminate in cæcal dilatations or saccules. Each saccule —about $\frac{1}{1200}$ of an inch in diameter—is filled with flattened, spheroidal epithelium, inclosing a nucleus, some of them having an outstanding process from the base of the cell. The saccule has a more or less developed basement membrane upon which the flattened cells rest. An aggregation of these saccules forms a small lobule, from which a small excretory duct proceeds; the lobules are united by intervening connective tissue, which is a continuation inwards of the dense fascia covering the gland. The small ramuscules have only a basement membrane with flattened cells, which rapidly change in the smaller ducts to a columnar form, while in the larger ducts the epithelium assumes the squamous variety.

To display the plexus of nerves (pes anserinus), formed by the branches of the facial in the parotid gland, find one of the larger branches, say one of the malar, on the face, and trace this into the substance of the gland, as a clue to the others.

PORTIO DURA, OR FACIAL NERVE. This is one of the divisions of the seventh pair of cranial nerves, and is the motor nerve of the face. It supplies all the muscles of expression, except those which move the eyes. It arises immediately below the pons Varolii, from the lateral tract of the medulla oblongata. The nerve enters the meatus auditorius internus, lying upon the auditory nerve, traverses a tortuous bony canal (*aqueductus Fallopii*) in the

the gland is enlarged by disease? John Bell, however, relates a case in which he was induced to attempt the extirpation of a diseased parotid ('Principles of Surgery,' vol. iii. p. 262). Other surgeons, too, of more modern date, have attempted the same thing. It is not unlikely that they have mistaken a tumour in the substance of the parotid for disease of the parotid itself.

petrous portion of the temporal bone, and leaves the skull at the stylo-mastoid foramen. Its course and connections in the temporal bone will be studied hereafter: at present we must trace the facial part of the nerve.

Having emerged from the stylo-mastoid foramen, the nerve enters the parotid gland, and soon divides into two primary branches, named, from their distribution, *temporo-facial* and *cervico-facial.* These primary branches cross over the external carotid artery and the external jugular vein, and form, by their communications within the substance of the parotid, the plexus called *pes anserinus*, from its fancied resemblance to the skeleton of a goose's foot. (Diagram, p. 4.)

Close to the stylo-mastoid foramen, the facial nerve gives off its *posterior auricular* branch (p. 4), which ascends behind the ear and divides into two, an auricular and an occipital; the former supplies the retrahens and attollens aurem, the latter the posterior belly of the occipito-frontalis. This branch communicates with the great auricular n. and with the auricular branch of the pneumogastric. Its two next *branches* supply the posterior belly of the digastricus and the stylo-hyoideus. The digastric nerve enters the muscles by many filaments; the nerve to the stylo-hyoid is long and enters the muscle about the middle. The digastric branch communicates with the glosso-pharyngeal near the base of the skull: the stylo-hyoid branch with the sympathetic on the external carotid a. These two muscular nerves are frequently given off from a common branch.

The *temporo-facial* division, the larger of the two, crosses the external carotid and the neck of the jaw, receives two or more communications from the auriculo-temporal (branch of the fifth) and subdivides into temporal, malar, and infra-orbital branches.

The *temporal* branches ascend over the zygoma, supply the frontalis, the attrahens aurem, the orbicularis palpebrarum, the corrugator supercilii, and tensor tarsi, and communicate with filaments of the supra-orbital nerve, with the temporal branch of the superior maxillary n., and with the auriculo-temporal n.

The *malar* branches cross the malar bone, supply the orbicular muscle, and communicate with filaments of the lachrymal, the supra-orbital, the superior maxillary, and the malar branch of the superior maxillary.

The *infra-orbital* branches are the largest, and proceed transversely forwards beneath the zygomatici over the masseter, to supply the orbicularis oris, the elevators of the upper lip, and the muscles of the nose. Beneath the levator labii superioris there is a free communication with the infra-orbital branches of the superior maxillary nerve, forming the *infra-orbital plexus.* Along the side of the nose the terminal filaments join the nasal and infra-trochlear branches of the ophthalmic.

The *cervico-facial* division, joined in the parotid gland by filaments from the auriculo-parotidean (branch of the cervical plexus), descends towards the angle of the jaw, and subdivides into buccal, supra- and infra-maxillary branches.

The *buccal* branches pass forwards over the masseter parallel with the parotid duct, and supply the buccinator: they communicate with the buccal branch of the inferior maxillary nerve (third division of the fifth).

The *supra-maxillary* branches advance over the masseter and facial artery, and run under the depressor muscles of the lower lip, all of which they supply. Some of the filaments communicate with the mental branch of the inferior dental nerve.

The *infra-maxillary* or cervical branches, one or more in number, were dissected with the neck (p. 21). They arch forwards below the jaw covered by the platysma, as low as the hyoid bone, and communicate with the superficial cervical (branch of the cervical plexus).

Respecting the function of the facial nerve, it is, at its origin, purely a motor nerve; but after leaving the stylo-mastoid foramen it becomes a compound nerve, in consequence of the filaments which it receives from the auriculo-temporal branch of the fifth, and from the auriculo-parotidean branch of the cervical plexus. These communications explain the pain which is often felt in facial paralysis along the track of the facial nerves.

Sensory Nerves of the Face. These are the supra-orbital, the supra- and infra-trochlear, the naso-lobular, the temporo-malar, the infra-orbital, and the mental, all branches of the fifth pair.

The *supra-orbital nerve* is a branch of the first division of the fifth pair. It leaves the orbit through the supra-orbital notch, and is at first covered by the orbicularis and occipito-frontalis. But it presently divides into wide-spreading branches, which supply the skin of the forehead, upper eyelid, and scalp. It communicates with the facial nerve on the forehead. The supra-orbital artery is a branch of the ophthalmic.

The *supra-trochlear n.*, or internal frontal, appears at the inner angle of the orbit, and sends down, in front of the pulley of the obliquus superior oculi, a loop to communicate with the infra-trochlear. Its further course has been described (p. 4).

The *infra-trochlear n.* issues from the orbit below the pulley, and supplies branches to the eyelids, the mucous membrane, lachrymal sac, and the side of the nose.

The *infra-orbital nerve* is the terminal branch of the superior maxillary or second division of the fifth nerve. It emerges with its artery from the infra-orbital foramen, covered by the levator labii superioris. The nerve immediately divides into several branches, *palpebral*, *nasal*, and *labial*; the palpebral, ascending beneath the orbicularis, supply the lower eyelid, and communicate with the facial: the nasal pass inwards to supply the nose and join the nasal branch (naso-lobular) of the first division of the fifth; the labial, by far the most numerous, descend into the upper lip, and eventually terminate in lashes of filaments, which endow the papillæ of the lip with exquisite sensibility. Close to the infra-orbital foramen is the infra-orbital plexus, before alluded to (p. 92).

The *infra-orbital artery* is the terminal branch of the internal maxillary; it supplies the muscles, the skin, and the front teeth of the upper jaw, and inosculates with the transverse facial, buccal, facial, and coronary arteries.

The *naso-lobular nerve* is distributed to the tip and lobule of the nose, and is joined by filaments from the facial nerve.

The *temporo-malar nerve*, one or more (branch of the superior maxillary), issues through the canal in the malar bone and supplies the cheek and side of the temple.

The *mental nerve* is a branch of the inferior maxillary or third division of the fifth. It emerges from the mental foramen in the lower jaw, in a direction upwards and backwards, beneath the depressor labii inferioris. It soon divides into a number of branches, some of which supply the skin of the chin, but the greater number terminate in the papillæ of the lower lip. It communicates with the facial nerve.

The *mental artery* is a branch of the inferior dental. It supplies the gums and the chin, and inosculates with the sub-mental, the inferior labial, and inferior coronary arteries.

MUSCLES OF MASTICATION.—TEMPORAL AND PTERYGO-MAXILLARY REGIONS.

In this dissection, the parts should be examined in the following order:

1. Superficial arteries and nerves of the temple.
2. Masseter muscle.
3. Temporal aponeurosis.
4. Temporal muscle.
5. Pterygoid muscles.
6. Internal maxillary artery and branches.
7. Inferior maxillary nerve and branches.

Reflect the skin of the temple from below upwards. Beneath the skin you come upon a layer of tough connective tissue, continuous, above, with the aponeurosis of the scalp, below, with the fascia covering the masseter and the parotid gland. In this tissue are contained the superficial temporal vessels and nerves.

[illegible] This is the smaller of the two terminal branches of the external carotid. Arising in the substance of the parotid gland near the neck of the jaw, it passes over the root of the zygoma, close to the meatus auditorius, ascends for about 1½ inches on the temporal fascia, and there divides into an anterior and a posterior branch. Above the zygoma it is superficial, being covered only by the attrahens

aurem; here it is accompanied by the auriculo-temporal branch of the inferior division of the fifth nerve. It gives off the following branches:

a. Several small branches to the parotid gland, the temporo-maxillary articulation, and the masseter.

b. The *transversalis faciei* (p. 87).

c. The *anterior auricular* branches, two in number, *superior* and *inferior*, ramify on the front of the pinna of the ear, inosculating with the posterior auricular.

d. The *middle temporal*, a small vessel, pierces the temporal fascia above the zygoma, and running in the substance of the temporal muscle, anastomoses with the temporal branches of the internal maxillary.

Of the two branches into which the temporal divides, the *anterior* runs tortuously towards the external angle of the frontal bone, distant from it about an inch. Its ramifications extend over the forehead, supplying the orbicularis and frontalis m., and inosculate with the supra-orbital and frontal arteries. The *posterior* runs towards the back of the head, and inosculates freely with the occipital and posterior auricular. The anterior branch, although the smaller, is usually selected for arteriotomy, the posterior being covered by a strong and unyielding fascia.

AURICULO-TEMPORAL NERVE. This nerve supplies the temple and side of the head with common sensation. It arises from the third division of the fifth pair by two roots (between which the middle meningeal artery runs). From its origin it proceeds outwards beneath the external pterygoid, between the neck of the jaw and the internal lateral ligament. It then ascends beneath the parotid, over the root of the zygoma, where it accompanies the temporal artery, and divides, like it, into an *anterior* and a *posterior* branch. Its ramifications correspond with those of the artery.

Near the condyle of the jaw the auriculo-temporal nerve sends round the external carotid artery communicating branches to the upper division of the facial nerve, endowing it with common sensibility. It here distributes *branches* to the parotid gland, the meatus auditorius, the membrana tympani, and the articulation of the jaw. Above the zygoma it gives off two filaments (*auricular*), an upper and a lower; the *upper* ramifies in the skin of the outer

aspect of the ear, mainly on the tragus and upper half of the auricle; the *lower* supplies the lobule and lower part of the pinna.

Lastly, in the subcutaneous tissue of the temple, we find the temporal branches of the facial nerve, which supply the frontalis, the attrahens aurem, the orbicularis palpebrarum, tensor tarsi, and corrugator supercilii.

MASSETER MUSCLE. This muscle *arises* from the lower edge of the zygoma, and is *inserted* into the outer side of the ramus and coronoid process of the jaw. The masseter is composed of superficial and deep fibres which cross like the letter X. The superficial fibres, constituting the principal part of the muscle, arise from the anterior two-thirds of the zygoma by tendinous fibres which occupy the front border of the muscle, and send aponeurotic partitions into its substance. These fibres pass downwards and backwards, this direction giving them greater advantage, and are inserted into the angle and part of the ramus of the jaw. The deep fibres, mainly muscular (which are concealed by the parotid gland), arise from the posterior third of the zygoma, incline forwards, and are inserted into the upper half of the ramus and the coronoid process. Besides these, a few fibres, arising from the inner surface of the zygoma, are inserted into the coronoid process and the tendon of the temporal muscle. Its *action* is to raise the jaw and help to masticate the food.

The following objects lie upon the masseter: 1. Glandula socia parotidis, and parotid duct: 2. Transversalis faciei artery: 3. Facial artery and vein: 4. Branches of the facial nerve.

DISSECTION. Reflect the masseter from its origin and turn it downwards. Observe the direction of the superficial and deep fibres, and the tendinous partitions which augment the power of the muscle by increasing its extent of origin. The masseteric nerve and artery enter the under surface of the muscle near to its posterior border, through the sigmoid notch of the jaw; the artery comes from the internal maxillary, the nerve from the motor division of the inferior maxillary.

TEMPORAL APONEUROSIS. This strong shining membrane covers the temporal muscle; its chief use being to give additional

origin to its fibres. It is attached above to the temporal ridge, and increasing in thickness as it descends, divides near the zygoma into two layers, which are attached to the outer and inner surfaces of the zygomatic arch. These layers are separated by fat, in which is found a filament from the orbital branch of the superior maxillary nerve. The density of this aponeurosis explains why abscesses in the temporal fossa rarely point outwards; the pus generally makes its way, beneath the zygoma, into the mouth.

Reflect the aponeurosis, and notice that it is separated from the temporal muscle, near the zygoma, by fat. The absorption of this fat, and the wasting of the muscle, occasion the sinking of the temple in emaciation and old age.

TEMPORAL MUSCLE. This muscle *arises* from the whole of the temporal fossa (except the malar surface) and the temporal aponeurosis. Its fibres converge to a strong tendon which is inserted into the inner surface, the apex, and anterior border of the coronoid process.

The fibres of the muscle converging from their wide origin, pass under the zygomatic arch, and terminate upon their tendon, the outer surface of which is partially concealed by the insertion of those fibres which come from the temporal aponeurosis: remove them, and see how admirably this tendon radiates into the muscle like the ribs of a fan. Its nerves (two deep temporal) are branches of the inferior maxillary (p. 104).

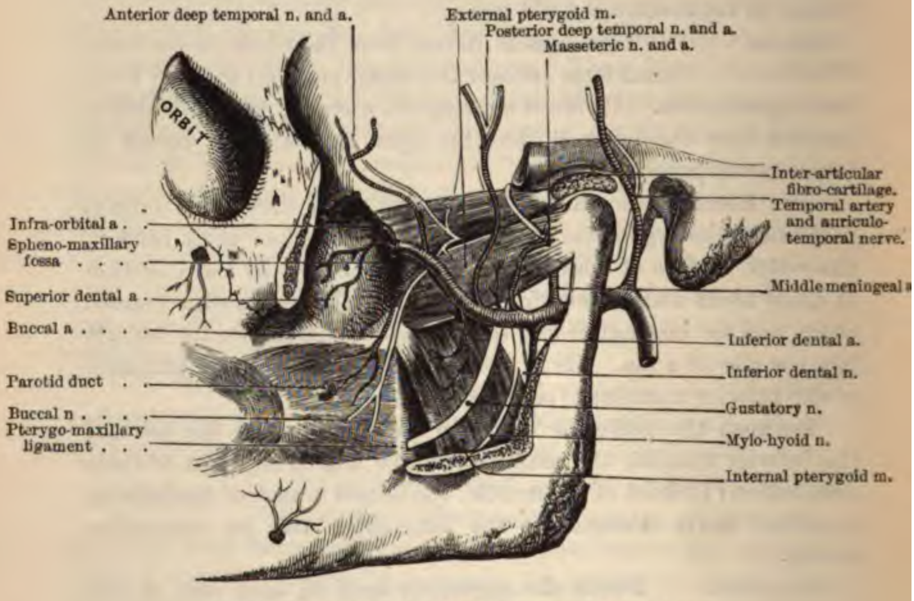
Between the posterior border of this muscle and the neck of the inferior maxilla, the masseteric nerve and artery pass to their destination: in front of the muscle, the buccal branch of the inferior maxillary nerve descends to the buccinator with its companion artery.

PTERYGO-MAXILLARY REGION. Divide the zygomatic arch on each side of the masseter, and turn it down, to expose the coronoid process of the jaw, the insertion of the temporal muscle, and the loose fat which surrounds it. Next, saw through the coronoid process in a direction downwards and forwards, so as to include the insertion of the muscle, and reflect it upwards without injuring the subjacent vessels and nerves.

DISSECTION. To gain a good view of the muscles, nerves, and vessels of the pterygo-maxillary region, a portion of the ascending ramus of the jaw must be removed with a Hey's saw, as shown in the diagram below.

In this region we have to examine the two pterygoid muscles, the trunk and branches of the internal maxillary artery, the inferior maxillary nerve, and the internal lateral ligament of the lower jaw. All these structures are imbedded in loose soft fat, which must be cautiously removed without injuring them.

FIG. 16.



PTERYGOID MUSCLES AND INTERNAL MAXILLARY ARTERY.

EXTERNAL PTERYGOID. This muscle *arises* by two heads, one, the upper, from the great wing of the sphenoid and from the ridge below it; the lower, from the outer surface of the external pterygoid plate, a few fibres taking origin from the outer side

of the tuberosities of the palate and superior maxillary bones. It is *inserted* into the neck of the jaw, and slightly into the border of the inter-articular fibro-cartilage of the jaw.

The advantage of the insertion of some of its fibres into the inter-articular cartilage is, that the cartilage follows the condyle in all its movements. When the jaw is dislocated, it is chiefly by the action of this muscle, which draws the condyle forwards into the zygomatic fossa; the inter-articular cartilage being dislocated with the condyle.

INTERNAL PTERYGOID. This muscle *arises* from the inner surface of the external pterygoid plate of the sphenoid bone, and the tuberosity of the palate bone. It is *inserted* into the inner side of the angle of the jaw, as high as the dental foramen.

Notice particularly the direction of the fibres of the pterygoid muscles. The fibres of the external run horizontally outwards and backwards from their origin; the fibres of the internal run downwards, backwards and outwards from their origin. The internal pterygoid has tendinous septa like the masseter. Both the pterygoids get their nerves from the motor division of the inferior maxillary.

The pterygoid muscles produce the lateral movements of the jaw essential to the mastication of the food. Consequently they are enormously developed in all ruminants, and comparatively feebly in carnivorous animals.

DISSECTION. Saw through the neck of the jaw, disarticulate the condyle with its fibro-cartilage from the glenoid cavity, and turn it forwards with the external pterygoid, so that the condyle can be replaced if desirable. A little dissection will bring into view the internal lateral ligament, and the internal maxillary artery.

INTERNAL MAXILLARY ARTERY. This is the larger of the two terminal branches into which the external carotid divides opposite the neck of the jaw. It passes horizontally forwards between the neck of the jaw and the internal lateral ligament, then runs tortuously, in some cases above, in others beneath the external pterygoid, enters the spheno-maxillary fossa between the two heads of the

external pterygoid, and terminates by dividing into numerous branches.

The course of this artery is divided into three stages. In the first, the artery lies between the neck of the jaw and the internal lateral ligament; in the second, it lies either over or under the external pterygoid; in the third, it lies in the spheno-maxillary fossa.

BRANCHES OF THE INTERNAL MAXILLARY ARTERY IN THE THREE STAGES OF ITS COURSE.

Branches in the First Stage.	Branches in the Second Stage.	Branches in the Third Stage.
a. Tympanic.	Six to the five muscles of mastication, namely:	*i*. Superior dental.
b. Meningea media.	*e*. Masseteric.	*j*. Infra-orbital.
c. Meningea parva.	*f*. Anterior and posterior temporal.	*k*. Descending palatine.
d. Inferior dental.	*g*. External and internal pterygoid.	*l*. Vidian.
	h. Buccal.	*m*. Pterygo-palatine.
		n. Nasal or spheno-palatine.

Branches in the First Part. *a*. The *tympanic* ascends behind the articulation of the jaw, and passes through the Glaserian fissure to the tympanum. It supplies that cavity and the membrana tympani, and anastomoses with the stylo-mastoid and Vidian arteries. This artery is not infrequently given off from a branch of the internal maxillary artery.

b. The *middle meningeal* artery ascends between the two roots of the auriculo-temporal nerve, behind the external pterygoid, and enters through the foramen spinosum into the cranium, where it ramifies between the dura mater and the bones. Its further course is described at p. 12.

c. The *meningea parva* (not marked in the plan) ascends through the foramen ovale into the skull, and supplies chiefly the ganglion of the fifth pair. It often comes from the meningea media.

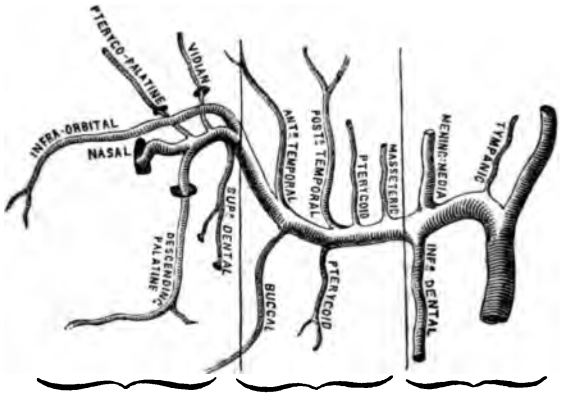
d. The *inferior dental* artery descends behind the neck of the jaw to the dental foramen, which it enters with the dental nerve. It then pro-

ceeds through a canal in the diploë to the symphysis, where it minutely inosculates with its fellow. In this canal, which runs beneath the roots of all the teeth, the artery gives branches which ascend through the little foramina in the fangs, and supply the pulp in their interior. Opposite the foramen mentale arises the mental branch already described (p. 94). Before entering the dental foramen the artery furnishes a small branch—*mylo-hyoid*—which accompanies the nerve proceeding to the mylo-hyoid muscle.

BRANCHES IN THE SECOND PART.

e. The *masseteric* branch passes through the sigmoid notch of the jaw to the under surface of the masseter, with the masseteric nerve, and inosculates with the facial artery.

FIG. 17.



Third stage. Second stage. First stage.

PLAN OF INTERNAL MAXILLARY ARTERY.

f. The *anterior* and *posterior temporal* arteries ascend to supply the temporal muscle, ramifying between the muscle and the bone, one near the front, the other near the posterior border of the muscle. They communicate with the superficial and middle temporal arteries, and with the terminal branches of the lachrymal a.

g. The *pterygoid* branches supply the internal and external pterygoid muscles.

h. The *buccal* branch runs forward with the buccal nerve to the buccinator, where it anastomoses with the facial artery.

BRANCHES IN THE THIRD PART.

i. The *superior dental* branch runs along the tuberosity of the superior maxillary bone, and sends small arteries through the foramina in the bone to the pulps of the molar and bicuspid teeth. It also supplies the gums, and the mucous membrane of the antrum.

j. The *infra-orbital* branch ascends through the spheno-maxillary fissure, then runs forward along the infra-orbital canal with the superior maxillary nerve, and emerges upon the face at the infra-orbital foramen. In the infra-orbital canal the artery sends branches downwards through little canals in the bone to the incisor and canine teeth, and upwards into the orbit to the inferior oblique and inferior rectus. After issuing from the foramen it sends upward branches to the lachrymal sac, and descending branches to the upper lip. The former anastomose with the nasal branches of the ophthalmic and facial arteries; the latter with the superior coronary, transverse facial, and buccal arteries.

k. The *descending palatine*, a branch of considerable size, runs down the posterior palatine canal with the palatine nerve (a branch from Meckel's ganglion), and then along the roof of the hard palate, towards the anterior palatine canal, in which, much diminished in size, it inosculates on the septum nasi with a branch of the spheno-palatine artery. It supplies the gums, the glands, and mucous membrane of this part, and furnishes branches to the soft palate.

l. The *Vidian*, an insignificant branch, runs backwards through the Vidian canal with the Vidian nerve, and is distributed to the Eustachian tube, the pharynx, and the tympanum.

m. The *pterygo-palatine* is a small but constant branch which runs backwards through the pterygo-palatine canal, and ramifies upon the upper part of the pharynx and the Eustachian tube.

n. The *nasal* or *spheno-palatine* branch enters the nose through the spheno-palatine foramen in company with the nasal nerve from Meckel's (spheno-palatine) ganglion, and ramifies upon the spongy bones, the ethmoidal cells, and the antrum. One large branch, the *artery of the septum*, runs along the septum nasi towards the anterior palatine canal, where it joins the descending palatine a.

Observe that all the branches of the internal maxillary artery in the first and third parts of its course traverse bony canals; while the branches in the second part go directly to muscles.

The *internal maxillary* vein is formed by the veins correspond-

ing to the branches of the artery. As the vein lies between the temporal and external pterygoid muscles it forms a plexus—*pterygoid plexus*—which communicates, above, with the cavernous sinus by branches which come through the foramina at the base of the skull; in front it communicates with the facial vein. It joins the temporal in the substance of the parotid gland, and thus communicates with the external jugular vein.

Pterygoid Plexus of Veins.

Inferior Maxillary Nerve and Branches.

This great nerve is the largest of the three divisions of the fifth cerebral nerve. It differs from the other two divisions, i.e. the ophthalmic and the superior maxillary, in that it contains motor as well as sensory filaments; the motor being furnished by the small non-ganglionic root of the fifth nerve. It is necessary to remember this point of its physiology, in order to understand its extensive distribution; for the sensory portion supplies the parts to which it is distributed with common sensation only, whilst the motor portion supplies all the muscles concerned in mastication.

The nerve, then, composed of sensory and motor filaments, emerges from the skull through the foramen ovale as a thick trunk, under the name of the inferior maxillary. It lies directly external to the Eustachian tube, and is covered by the external pterygoid muscle, which must be turned on one side to expose it. Immediately after its exit from the skull, the nerve divides into two parts, an anterior, or motor division, and a posterior or sensory division. From the *anterior* portion (chiefly motor) are derived branches distributed to the muscles of mastication. From the *posterior* (mainly sensory) come the following branches: the auriculo-temporal, gustatory, inferior dental and buccal; there are also motor branches to the mylo-hyoid and anterior belly of the digastricus. This apparent anomaly will be presently explained.

BRANCHES OF THE INFERIOR MAXILLARY NERVE.

Sensory Branches.	Motor Branches.
Auriculo-temporal.	To temporal muscle.
Inferior dental.	— masseter.
Buccal.	— external pterygoid.
Gustatory or lingual.	— internal pterygoid.
	— mylo-hyoideus.
	— anterior belly of digastricus.

The branches to the *temporal* muscle, two in number, *anterior* and *posterior*, pass outwards close to the great wing of the sphenoid bone, and ascend with the temporal arteries to the muscle.

The branch to the *masseter* runs outwards above the external pterygoid, through the sigmoid notch of the jaw, to the under surface of the muscle.

The branch to the *external pterygoid* comes, apparently, from the buccal nerve in its passage through this muscle.

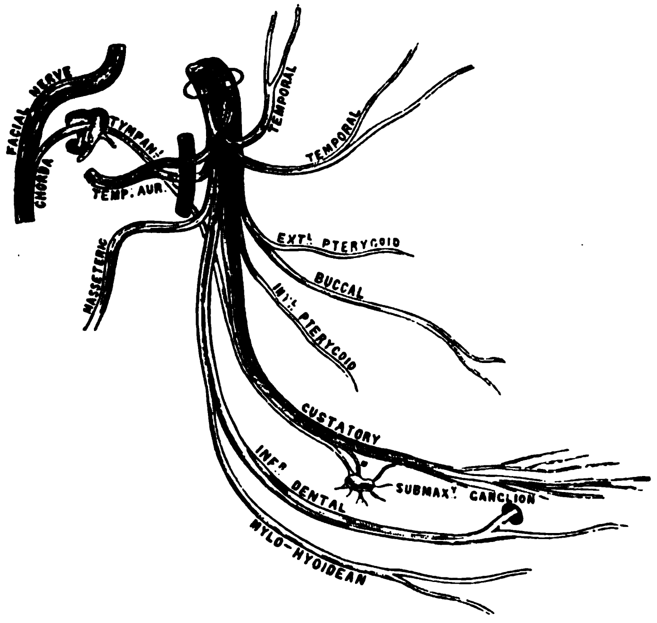
The branch to the *internal pterygoid* muscle proceeds from the inner side of the main trunk, close to the otic ganglion, and descending between the internal pterygoid and the tensor palati, enters the inner aspect of the muscle.

The *buccal* branch passes either above or between the fibres of the external pterygoid to the buccinator, where it spreads out into filaments, which supply the skin, mucous membrane, and glands of the cheek with common sensation. The motor power of the buccinator, remember, is derived from the facial nerve. That this buccal branch is mainly sensory is proved by the action of the muscle still continuing when the motor division of the fifth nerve is paralysed. The evidence is corroborated by a case in which this buccal branch proceeded from the second division of the fifth nerve; no communication being discovered, after very

careful dissection, between it and the motor root of the third division.*

The *auriculo-temporal* branch arises by two roots which embrace the middle meningeal artery before it enters the skull. The nerve runs outwards behind the external pterygoid and the neck of the jaw, ascends over the root of the zygoma with the temporal artery, and divides, like it, into an anterior and a posterior branch: these are distributed to the skin of the side of the head. Behind

FIG. 18.



PLAN OF THE BRANCHES OF THE INFERIOR MAXILLARY NERVE.

the condyle it sends filaments to the meatus auditorius, to the skin on the outer aspect of the ear, and to the articulation of the jaw. It distributes also filaments to the parotid gland, and one

* Turner, 'On the Variation of the Buccal Nerve.' 'Journal of Anat. and Phys.,' No. I. 1866.

especially to the upper division of the facial, which endows it with common sensibility: its branches have been described (p. 95).

The *inferior dental* branch emerges beneath the external pterygoid, and descends between the ramus and the internal lateral ligament of the jaw to the dental foramen, which it enters with the dental artery. It then runs in the canal in the diploë of the jaw and furnishes filaments which ascend through the canals in the fangs of the teeth to the pulp in their interior. Opposite the foramen mentale it divides into two branches, the *mental* and *incisor*. Observe that the same nerve which supplies the teeth supplies the gums; hence the sympathy between them.

a. The *mylo-hyoid* branch, apparently arising from the dental, is derived from the motor root of the fifth, and may, with careful dissection, be traced to it. It leaves the sheath of the inferior dental nerve near the foramen in the jaw, and runs in a groove on the inner side of the ramus to the lower surface of the mylo-hyoid, which muscle, together with the anterior portion of the digastricus, it supplies.

b. The *dental* branches pass upwards to the fangs of the molar and bicuspid teeth.

c. The *incisor* branch is the continuation of the nerve, and passes to the symphysis, supplying the canine and incisor teeth.

d. The *mental* branch (sometimes called *labial*) emerges through the foramen mentale, and soon divides into numerous branches; some ascend to the lower lip beneath the depressor labii inferioris, and communicate with the facial nerve; others pass inwards to the skin of the chin.

The *gustatory* or *lingual* nerve lies at first behind the external pterygoid m., then descends obliquely forwards between the ramus of the jaw and the internal pterygoid m., and subsequently for a short distance between the jaw and the superior constrictor of the pharynx. Here it lies close under the mucous membrane of the mouth near the last molar tooth of the lower jaw. Division of it in this situation has relieved pain in cancer of the tongue. The gustatory n. then rests upon the stylo-glossus and the hyo-glossus m., and after crossing Wharton's duct passes to the tip of the tongue.

The nerve at first lies in front of the inferior dental nerve (with which it is frequently connected), and beneath the internal maxillary a. Beneath the external pterygoid the gustatory n. is joined at an acute angle by the *chorda tympani* (a branch of the facial). This branch emerges through the Glaserian fissure, or through a small canal by the side of it, and passing behind the dental n., meets the gustatory, and runs along the lower border of this nerve to join the submaxillary ganglion. It is eventually distributed to the lingualis muscle.

The gustatory in its course gives off:

a. Communicating branches to the hypoglossal n., forming two or more loops at the anterior border of the hyo-glossus.

b. Branches to the submaxillary ganglion.

c. Branches to the mucous membrane of the mouth, gums, and sub-lingual gland.

d. Branches which pass to the papillæ of the sides and tip of the tongue: here also we find communications between this nerve and the hypoglossal.

INTERNAL LATERAL LIGAMENT OF THE LOWER JAW. This so-called ligament (which is more like a layer of fascia) passes from the spinous process of the sphenoid bone to the inner side of the foramen dentale. Between this ligament and the neck of the jaw, we find the internal maxillary artery and vein, the auriculo-temporal nerve, the middle meningeal artery, the dental nerve and artery, and a portion of the parotid gland.

At this stage of the dissection you will be able to trace the course and relations of the internal carotid artery. But before doing this, examine the several objects which intervene between the external and internal carotids. These are—1. The stylo-glossus: 2. The stylo-pharyngeus: 3. The glosso-pharyngeal nerve: 4. The stylo-hyoid ligament.

STYLO-GLOSSUS. This *arises* from the styloid process near the apex, and the stylo-maxillary ligament, and is *inserted* along the side of the tongue, external to the hyo-glossus. Its action is to retract the tongue. Its nerve is a branch of the hypoglossal.

STYLO-PHARYNGEUS. This *arises* from the inner side of the styloid process near the base, and is *inserted* into the upper and posterior edges of the thyroid cartilage. It descends along the side of the pharynx between the superior and the middle constrictors. Curving round its lower border is seen the glosso-pharyngeal nerve. Its nerve comes from the pharyngeal plexus. Its *action* is to raise the larynx with the pharynx in deglutition.

Between the stylo-glossus and stylo-pharyngeus, and nearly parallel with both, is the *stylo-hyoid ligament*. It extends from the apex of the styloid process to the lesser cornu of the os hyoides. It is often more or less ossified.

The *ascending palatine artery*, a branch of the facial (p. 45), runs up between the stylo-glossus and the stylo-pharyngeus, and divides into branches which supply these muscles, the palate, the side of the pharynx, and the tonsils. It inosculates with the descending palatine, a branch of the internal maxillary.

GLOSSO-PHARYNGEAL NERVE. The glosso-pharyngeal nerve is observed curving forwards under the lower border of the stylo-pharyngeus (p. 48). It is one of the divisions of the eighth pair, arises by five or six filaments from the restiform tract of the medulla oblongata, leaves the skull through the anterior part of the foramen jugulare in a separate sheath of dura mater, in front of the remaining divisions of the eighth pair, and descends between the internal jugular vein and the internal carotid artery. It then crosses in front of the artery and proceeds along the lower border of the stylo-pharyngeus. At this point, it curves forwards over that muscle and the middle constrictor of the pharynx, and disappears beneath the hyo-glossus, where it divides into its terminal branches, which supply the mucous membrane of the pharynx, the back of the tongue, and the tonsils.

The glosso-pharyngeal is regarded, at its origin, as purely a sensory nerve. But soon after its exit from the skull it receives communications from the facial, the pneumogastric, and the sympathetic, so that it soon becomes a compound nerve—i.e.

composed of both sensory and motor filaments. At the base of the skull it presents two ganglia—the *jugular* and the *petrous* (ganglion of Andersch). The branches given off by these ganglia will be dissected hereafter; at present the student can only make out the branches which this nerve gives off in the neck, namely:

Carotid branches, which surround the internal carotid artery, and communicate with the pharyngeal branch of the pneumogastric and with the sympathetic.

Pharyngeal branches, which form by the side of the middle constrictor of the pharynx, a plexus, the **pharyngeal plexus**, supplemented by filaments derived from the pneumogastric, the nervus accessorius, the external laryngeal, and the sympathetic. Its branches supply the constrictor muscles and the mucous membrane of the pharynx, the back of the tongue, and the tonsils.

Muscular branches which enter the stylo-pharyngeus m.

Tonsillar branches which are given to the soft palate and the tonsils forming a plexus (circulus tonsillaris).

Lingual branches, which are distributed to the base and lateral aspects of the tongue.

The styloid process must now be cut through at its base, and turned forwards with the muscles arising from it. The internal carotid artery will thus be exposed in the cervical region, as far as the carotid canal. The part of the artery contained within the carotid canal will be described hereafter.

INTERNAL CAROTID ARTERY.

The *internal carotid artery* proceeds from the bifurcation of the common carotid at the upper border of the thyroid cartilage, and ascends to the base of the skull *by the side of the pharynx*, close to the transverse processes of the three upper cervical vertebræ. It enters the skull through the carotid canal in the temporal bone, runs tortuously by the side of the body of the sphenoid, and terminates in branches which supply the orbit and the brain. In the *cervical part* of its course, it is situated immediately to the outer side of the external carotid artery, behind the inner border of the sterno-mastoid. It soon gets beneath the external carotid, and lies deeply

seated by the side of the pharynx and tonsil. It lies upon the rectus capitis anticus major, the superior laryngeal, sympathetic. and pneumogastric nerves. It is crossed, successively, by the hypoglossal nerve, the occipital artery, the digastricus and stylo-hyoid muscles; higher up it is crossed obliquely by the styloid process, the stylo-glossus and stylo-pharyngeus muscles, by the glosso-pharyngeal nerve, and the stylo-hyoid ligament, all of which last-named structures intervene between it and the external carotid. On the outer side of the artery is the internal jugular vein; and on the inner, the pharynx, the tonsil, and the ascending pharyngeal artery.

The most important relation of the artery, in a surgical point of view, is, that it ascends close by the *side of the pharynx* and *tonsil.* In opening an abscess, therefore, near the tonsil, or at the back of the pharynx, be careful to introduce the knife with its point inwards towards the mesial line: observe this caution the more, because, in some subjects, the internal carotid makes a curve, or even a complete curl upon itself, in its ascent near the pharynx. In such cases an undue deviation of the instrument in an outward direction would injure the vessel.

ASCENDING PHARYNGEAL ARTERY.

This artery generally arises from the external carotid about half an inch above the angle of the common carotid. It ascends in a straight course between the internal carotid artery and the side of the pharynx, towards the base of the skull, resting upon the rectus capitis anticus major. It gives off branches which supply the pharynx, the tonsil, the Eustachian tube, and the muscles in front of the spine. A very constant branch, the *palatine,* runs down with the levator palati, above the superior constrictor of the pharynx, and supplies the soft palate. It also sends small meningeal branches to supply the dura mater; one of which ascends through the foramen lacerum medium, another through the foramen jugulare with the internal jugular vein.

PNEUMOGASTRIC NERVE.

The pneumogastric nerve is the largest and longest of the three divisions of the eighth pair of

cerebral nerves. It arises from the medulla oblongata by a series of roots, twelve to fifteen in number, along the restiform tract. It passes out of the skull in a common sheath with the nervus accessorius through the foramen jugulare.

Leaving the skull at the foramen jugulare, the nerve descends in front of the cervical vertebræ, lying successively upon the rectus capitis anticus major and the longus colli. In the upper part of the neck it is situated behind the internal carotid artery: lower down, it lies between and behind the common carotid and the internal jugular vein. It enters the chest, on the right side, crossing in front of the subclavian artery nearly at a right angle; on the left, running nearly parallel with it.

In their course through the chest, the pneumogastric nerves have not similar relations. The *right* nerve lies beneath the subclavian vein, and then descending behind the right brachio-cephalic vein by the side of the trachea, is continued behind the right bronchus to the posterior part of the œsophagus. The *left* nerve passes behind the left brachio-cephalic vein, then crosses in front of the arch of the aorta, and behind the left bronchus to the anterior part of the œsophagus. Both nerves subdivide on the œsophagus into a plexus; the right nerve forming the *posterior œsophageal plexus*, the left the *anterior*. Each plexus again collects its fibres together to form a single trunk: thus two main nerves are formed which pass with the œsophagus through the diaphragm: of these the right is distributed over the posterior, the left over the anterior surface of the stomach.*

In their long course from the medulla oblongata to the abdomen, the pneumogastric nerves supply branches to most important organs; namely, to the pharynx, the larynx, the heart, the lungs, the œsophagus, the stomach, and the liver.

Within the foramen jugulare a small ganglion—*ganglion of the root*—(Arnold's ganglion) is situated upon the pneumogastric

* The differences in the course and destination of the right and the left pneumogastric nerves may be explained in the process of development. The student is therefore referred to works which treat of this subject.

nerve, and is joined by a branch from the nervus accessorius. This ganglion will be described hereafter. About half an inch below the preceding the pneumogastric nerve swells out, and forms a second ganglion—*ganglion of the trunk*—(inferior ganglion) of a reddish-grey colour. This ganglion occupies about an inch of the nerve, but does not involve the whole of its fibres; the branch from the spinal accessory not being included. It is united to the hypoglossal nerve, from which it receives filaments. It also receives filaments from the first and second spinal nerves, and from the superior cervical ganglion of the sympathetic.

Thus, the pneumogastric, at its origin probably a nerve of sensation only, becomes, in consequence of the connecting filaments from these various branches, a compound nerve, and in all respects analogous to a spinal nerve.

The branches of distribution of the pneumogastric are:

a. The *auricular* (Arnold), which cannot at present be seen, will be made out in the dissection of the eighth pair at the base of the skull.

b. The *pharyngeal* arises from the upper part of the ganglion of the trunk, and descends either in front of or behind the internal carotid. The nerve, after passing the inner side of the internal carotid, divides into branches, which with the other filaments (described p. 109) upon the middle constrictor muscle form the *pharyngeal plexus*. From this plexus branches are distributed to the muscles and the mucous membrane of the pharynx.

c. The *superior laryngeal*, derived from the middle of the ganglion of the trunk, descends behind the internal carotid, and divides into two branches, the internal and the external laryngeal.

The *internal laryngeal* passes to the interval between the os hyoides and the thyroid cartilage, and enters the larynx (with the superior laryngeal a.), through the thyro-hyoid membrane to be distributed to the mucous membrane of the larynx and epiglottis. The *external laryngeal*, the smaller, gives off some branches to the pharyngeal plexus and the inferior constrictor, and then descends beneath the depressors of the os hyoides to supply the crico-thyroid muscle.

d. The *cervical cardiac branches*, upper and lower, descend behind the sheath of the carotid artery to the cardiac plexus. The *upper* branch is small and proceeds from the ganglion of the trunk; the *lower* comes from the trunk of the pneumogastric before it enters the chest. Subsequently, the right lower cardiac nerve descends with the innominate artery to join the deep cardiac plexus; the left passes over the arch of the aorta to join the superficial cardiac plexus.

e. The *inferior* or *recurrent laryngeal nerve* turns, on the right side, under the subclavian artery (p. 61), and ascends obliquely inwards to the larynx behind the common carotid and the inferior thyroid arteries: it lies subsequently behind the trachea. On the left side, it turns under the arch of the aorta, just on the outer side of the remains of the 'ductus arteriosus;' after which it runs up between the trachea and the œsophagus. On both sides the nerves enter the larynx beneath the lower border of the inferior constrictor, and supply all the intrinsic muscles of the larynx, except the crico-thyroid. These nerves as they turn under their respective vessels give off branches to the deep cardiac plexus.

The remaining branches of the pneumogastric nerve to the lungs, heart, œsophagus and stomach will be examined in the dissection of the chest.

SPINAL ACCESSORY NERVE. The *spinal accessory nerve* issues through the anterior part of the foramen jugulare, in a sheath of dura mater common to it and the pneumogastric nerve. It arises by numerous filaments from the medulla oblongata, below the pneumogastric, and from the lateral column of the spinal cord as low down as the sixth cervical vertebra. These roots converge to the jugular foramen, where the nerve consists of two portions: one of which, the *internal* or *accessory*, joins the pneumogastric; the other, the *external* or *spinal*, is distributed to muscles.

The *accessory part*, within the foramen jugulare, sends one or more filaments to the ganglion of the root of the pneumogastric. It lies close to the pneumogastric nerve at the ganglion of the

trunk, and is finally incorporated with the nerve below the ganglion.

The *spinal part* separates from the accessory part below the foramen jugulare. It then takes a curved course backwards and outwards, lying in front of the transverse process of the atlas, and, after supplying the sterno-mastoid muscle, is distributed to the trapezius.

HYPOGLOSSAL NERVE. This nerve passes through the anterior condyloid foramen in two fasciculi which join outside the skull. The nerve comes forward between the internal jugular vein and the internal carotid artery, and then winds round the occipital artery. Its further course has been described (p. 49).

At the base of the skull it gives off several filaments which connect it with the ganglion of the trunk of the pneumogastric nerve. These two nerves are sometimes almost inseparably united. It gives off also several delicate filaments to the superior cervical ganglion of the sympathetic, and communicates with the loop formed by the first two spinal nerves in front of the atlas.

SYMPATHETIC NERVE. Now examine the cervical ganglia of the sympathetic system of nerves. This 'system' consists of a series of ganglia arranged on each side of the spine, from the first cervical to the last sacral vertebra. The successive ganglia of the same side are connected by intermediate nerves, so as to form a continuous cord on each side of the spine: this constitutes what is called the trunk of the sympathetic system, and is connected with all the spinal nerves. Its upper or cephalic extremity enters the cranium through the carotid canal, surrounds the internal carotid artery, communicates with the third, fourth, fifth, and sixth cranial nerves, and joins its fellow of the opposite side upon the anterior communicating artery.* Its sacral extremity joins its fellow by means of a little *ganglion impar*, situated in the mesial line, upon the coccyx.

* Here is situated the so-called *ganglion of Ribes.*

The ganglia, as already stated, are connected with the spinal nerves; this connection takes place by two filaments—one of white nerve-fibre which passes from the spinal nerve to the ganglion, the other, of grey, from the ganglion to the spinal nerve.

The different portions of the sympathetic gangliated cord receive, respectively, the distinguishing names of the cervical, dorsal, lumbar, and sacral. At present we have only to consider the cervical portion of it.

To expose the cervical portion of the sympathetic, the internal carotid artery, the pneumogastric, glosso-pharyngeal, and hypoglossal nerves should be cut through near the base of the skull; then by careful dissection the superior cervical ganglion can be traced out.

CERVICAL GANGLIA OF SYMPATHETIC. In the cervical portion of the sympathetic are three ganglia, named from their position, superior, middle, and inferior.

The *superior cervical ganglion*, the largest of the three, is situated near the base of the skull, opposite the second and third cervical vertebræ, and lies behind and on the inner side of the internal carotid artery, upon the rectus capitis anticus major. It is of a reddish-grey colour like the other ganglia, of an elongated oval shape, varying in length from one to two inches. To facilitate the description of its several branches we divide them into —1st, those which are presumed to connect it with other nerves; and 2ndly, those which originate from it.

It is then connected by branches as follow:—

a. With each of the four upper spinal nerves.

b. With the hypoglossal, with both ganglia of the pneumogastric, and with the glosso-pharyngeal.

c. Its important *cranial* branch runs with the internal carotid a. into the carotid canal of the temporal bone, and there divides into two, an outer and an inner. Now this *outer* branch accompanies the artery through its bony canal, ramifies upon it by the side of the body of the sphenoid, and so constitutes the 'CAROTID PLEXUS.' From this outer branch a filament proceeds to the Gasserian ganglion, another to the sixth

cranial nerve; a third joins the great petrosal branch of the facial, and forms the Vidian nerve. The *inner* branch, running on with the artery to the cavernous sinus, there forms another plexus, called from its position the 'CAVERNOUS PLEXUS.' Here the sympathetic is seen to communicate with the third, the fourth, and the ophthalmic branch of the fifth cranial n. Lastly, from both these plexuses secondary plexuses proceed, of which the minute filaments ramify on, and supply the coats of, the terminal branches of the internal carotid.

d. With the several ganglia of the sympathetic system about the head and neck; namely, the ophthalmic, spheno-palatine, otic, and submaxillary.

The branches which it distributes are—

e. Nerves to the Heart.—One or more (superior cardiac) descend behind the sheath of the carotid in front of the inferior thyroid artery and recurrent laryngeal nerve, and, entering the chest, join the superficial and deep cardiac plexuses.

f. Nerves to the Pharynx.—These join the pharyngeal plexus on the middle constrictor of the pharynx.

g. Nerves to the Blood-vessels.—These nerves, named on account of their delicacy *nervi molles*, ramify around the external carotid artery and its branches.

The *middle cervical ganglion* is something less than a barley-corn in size. It is situated behind the carotid sheath, about the fifth or sixth cervical vertebra, near the inferior thyroid artery. It receives branches from the fifth and sixth spinal nerves, and gives off—

a. Branches to the Thyroid Body.—These accompany the inferior thyroid artery, and join the external and recurrent laryngeal nerves.

b. Branch to the Heart.—This (middle cardiac) nerve usually descends, on the right side, in front of the subclavian artery into the chest, where it lies on the trachea. It is joined by some cardiac filaments from the recurrent laryngeal nerve, and joins the deep cardiac plexus. On the left side, this cardiac nerve lies between the carotid and subclavian arteries.

In cases where the middle cervical ganglion is absent, the preceding nerves are supplied by the sympathetic cord connecting the superior and inferior ganglia.

The *inferior cervical ganglion* is of considerable size, and is situated in the interval between the transverse process of the seventh cervical vertebra and the first rib, immediately behind the vertebral artery. It receives branches from the seventh and eighth spinal nerves, and others which, descending from the fourth fifth and sixth, through the foramina in the transverse processes of the vertebræ, form a plexus around the vertebral artery.

The branches which it gives off are—

a. Inferior Cardiac Nerve.—This communicates with the recurrent laryngeal and middle cardiac nerves, and joins the cardiac plexus beneath the arch of the aorta.

b. Nerves to the Blood-vessels.—These ramify around the vertebral and subclavian arteries.

DISSECTION OF THE THORAX.

Before the several organs contained in the thorax are examined, the student should have some knowledge of its framework. The true ribs with their cartilages describe a series of arcs increasing in length from above downwards, and form, with the dorsal vertebræ behind, and the sternum in front, a barrel of a conical shape, broader in the lateral than in the antero-posterior diameter. The base is closed in the recent state by a muscle, the diaphragm, which forms a muscular partition between the chest and the abdomen. This partition is arched upwards, so that it constitutes a vaulted floor for the chest, and by its capability of alternately falling and rising, it increases and diminishes the capacity of the thorax. The spaces between the ribs are occupied by the intercostal muscles. In each intercostal space there are two layers of these muscles arranged like the letter X. The fibres of the outer layer run obliquely from above downwards and forwards; those of the inner layer in the reverse direction.

Such, in outline, is the framework of the thorax, which contains the heart with its large vessels and the lungs. Its walls are composed of different structures—bone, cartilage, muscles and ligaments, which fulfil two important conditions: 1st, by their solidity and elasticity they protect the important organs contained in the thorax; 2ndly, by their alternate expansion and contraction they act as mechanical powers of respiration. For they can increase the capacity of the chest in three directions: in height, by the descent of the diaphragm; in width, by the rotation of the ribs; and in depth, by the elevation of the sternum.

Boundaries of the Thorax. The upper opening of the osseous thorax is bounded posteriorly by the body of the first dorsal

vertebra, laterally by the first ribs, and in front by the upper border of the manubrium sterni. The aperture gives passage to the trachea, the œsophagus, the large vessels of the head and neck and upper extremities, viz., the innominate, the left carotid and subclavian arteries, with the left innominate and right subclavian and internal jugular veins, the superior intercostal and internal mammary arteries, the middle thyroid veins, the sterno-hyoid, sterno-thyroid and longus colli muscles, the pneumogastric, the left recurrent laryngeal, the phrenic and the sympathetic nerves; the cardiac branches of the sympathetic, and the cardiac branches of the pneumogastric; also to the first dorsal nerve as it passes up to join the brachial plexus, the thoracic duct, the thymus gland (in early life), and lastly to the apices of the lungs, which, with their pleural coverings, rise up on each side into the neck for about one inch and a half above the first rib; the interspaces between these various structures being occupied by a dense fibro-cellular tissue.

The base of the thorax, formed by the diaphragm, descends in front (in the dead subject) on the right side as low as the upper border of the fifth rib; on the left as low as the upper border of the sixth rib.*

The chest of the female differs from that of the male in the following points:—Its general capacity is less: the sternum is shorter; the upper opening is larger in proportion to the lower; the upper ribs are more moveable, and therefore permit a greater

* That the student may have some knowledge of the diameters of the chest at different situations, the following measurements have been taken from a well-articulated male skeleton of the average height:—The *antero-posterior* diameter at the upper opening of the thorax is $2\frac{1}{4}$ inches, at the articulation of the manubrium with the gladiolus it is $4\frac{1}{2}$ inches, and at the junction of the gladiolus with the ensiform cartilage it has increased to $5\frac{5}{8}$ inches. The *transverse diameter* of the upper opening was found to be $4\frac{3}{8}$ inches; between the second ribs, 7 inches; between the third, $8\frac{1}{8}$ inches; the diameter increases in regular proportion as far as the ninth rib, where it attains a measurement of $10\frac{5}{8}$ inches; below this it gradually decreases. The articulation of the manubrium and the gladiolus is on a level with the fourth dorsal vertebra; the junction of the ensiform cartilage with the gladiolus is on a level with the border of the ninth or tenth dorsal vertebra; and, lastly, the upper border of the manubrium corresponds to the second dorsal vertebra.

enlargement of the chest at its upper part, in adaptation to the condition of the abdomen during pregnancy.

DISSECTION. An opening must be made into the chest, by carefully removing the upper four-fifths of the sternum, and the cartilages of all the true ribs.* In doing this, care must be taken not to wound the pleura, which is closely connected with the cartilages. On one side the internal mammary artery should be dissected; on the other, removed.

In the dissection of the chest let us take the parts in the following order:—

1. Triangularis sterni, with the internal mammary artery.
2. Mediastina, anterior, middle, and posterior.
3. Right and left brachio-cephalic veins and superior vena cava.
4. Course and relations of the arch of the aorta.
5. The three great branches of the arch.
6. Course of the phrenic nerves.
7. Position and relations of the heart.
8. Pericardium.
9. Pleura.
10. Position and form of the lungs.
11. Posterior mediastinum and its contents; namely, the aorta, the thoracic duct, the vena azygos, the œsophagus, and pneumogastric nerves.
12. Sympathetic nerve.
13. Intercostal muscles, vessels and nerves.
14. Nerves of the heart; cardiac plexuses.

TRIANGULARIS STERNI. On the under surface of the sternum and cartilages of the ribs is a thin flat muscle, named the *triangularis sterni*. It arises from the ensiform cartilage, the lower part of the sternum, and the cartilages of one or two lower true ribs, and is *inserted* by digitations into the cartilages of the true ribs from the sixth to the second: its fibres ascend outwards to their insertion. This muscle is evidently a continuation upwards of the anterior portion of the transversalis abdominis. Its

* Those who are more proficient in dissection should not remove the whole of the sternum, but leave a quarter of an inch of its upper part with the first rib attached to it. This portion serves as a valuable landmark, although it obstructs, to a certain extent, the view of the subjacent vessels.

action is to depress the costal cartilages, and thus, on emergency, it acts in expiration. Its nerves come from the intercostal nerves, its arteries from the internal mammary.

INTERNAL MAMMARY ARTERY. This artery is given off from the subclavian in the first part of its course. On entering the chest it lies between the cartilage of the first rib and the pleura and is crossed by the phrenic nerve. It then descends perpendicularly, about half an inch from the sternum, between the cartilages of the ribs and the triangularis sterni, as far as the seventh costal cartilage, where it divides into two branches, the *musculo-phrenic* and the *superior epigastric*. The latter branch then enters the wall of the abdomen behind the rectus abdominis, and finally inosculates with the epigastric (a branch of the external iliac). The branches of the internal mammary are as follows:—

a. Arteria comes nervi phrenici.—A very slender artery, which accompanies the phrenic nerve to the diaphragm, and anastomoses with the phrenic branches of the abdominal aorta.

b. Mediastinal and thymic.—These branches supply the cellular tissue of the anterior mediastinum, the pericardium, and the triangularis sterni. The *thymic* are only visible in childhood, and disappear with the thymus gland.

c. Anterior intercostal.—Two for each intercostal space are distributed to the five or six upper intercostal spaces. They lie at first between the pleura and the internal intercostal muscle, and subsequently between the two intercostals. They inosculate with the intercostal arteries from the aorta.

d. Perforating arteries, which pass through the same number of intercostal spaces as the preceding branches, and supply the pectoral muscle and skin of the chest. In the female they are of large size, to supply the mammary gland.

e. The *musculo-phrenic* branch runs outwards behind the cartilages of the false ribs, and terminates near the last intercostal space. It supplies small branches to the diaphragm, to the sixth, seventh, and sometimes the eighth intercostal spaces.

Two venæ comites accompany the artery, and form a single

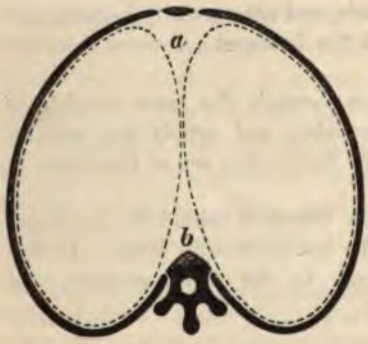
trunk at the upper part of the chest, which terminates in the brachio-cephalic vein of its own side.

LYMPHATIC GLANDS. There are several *lymphatic glands* in the neighbourhood of the internal mammary artery. They receive the lymphatics from the inner portion of the mammary gland, from the diaphragm, and the upper part of the abdominal wall. In disease of the inner portion of the mamma, these glands may enlarge without any enlargement of those in the axilla.

If a transverse section were made through the chest (*see* fig. 20), you would observe that as the pleuræ nowhere come into actual contact, a space is left between them extending from the sternum to the spine, and which is larger in the middle than in front or behind. This interval is called by anatomists the *interpleural space*, and for convenience sake is subdivided into an *anterior*, *middle*, and *posterior mediastinum*.

MEDIASTINA, ANTERIOR, MIDDLE AND POSTERIOR. The *mediastina* are the spaces which the two pleural sacs leave between them in the antero-posterior plane of the chest. There is an anterior, a middle, and a posterior mediastinum. To put these spaces in the simplest light, let us imagine the heart and lungs to be removed from the chest, and the two pleural sacs to be left in it by themselves. The two sacs, if inflated, would then appear like two bladders, in contact only in the middle, as shown by the dotted outlines in the annexed scheme (fig. 19). The interval marked *a*, behind the sternum, would represe t the anterior mediastinum; the interval *b*, the posterior mediastinum. Now let us introduce the heart again, between the two pleural sacs: these must give way to make room for it, so that the two sacs are largely separated in the middle line of the chest; and the space thus

FIG. 19.



occupied by the heart and large vessels takes the name of the middle mediastinum.

Looking at the chest in front, the *anterior mediastinum* appears as shown in the diagram (p. 125). It is not precisely vertical in its direction, for it inclines slightly towards the left, owing to the position of the heart. Its area varies: thus it is extremely narrow in the middle where the edges of the lungs nearly meet; but it is wider above and below, where the lungs diverge. Posteriorly it is limited by the pericardium covering the heart, aorta and its branches, and the pulmonary artery.

What parts are contained in the anterior mediastinum?—The remains of the thymus gland, the origins of the sterno-hyoid, sterno-thyroid, and triangularis sterni muscles, the left brachiocephalic vein (which crosses behind the first bone of the sternum) a few lymphatic glands, and the left internal mammary artery and veins.

Fig. 20.

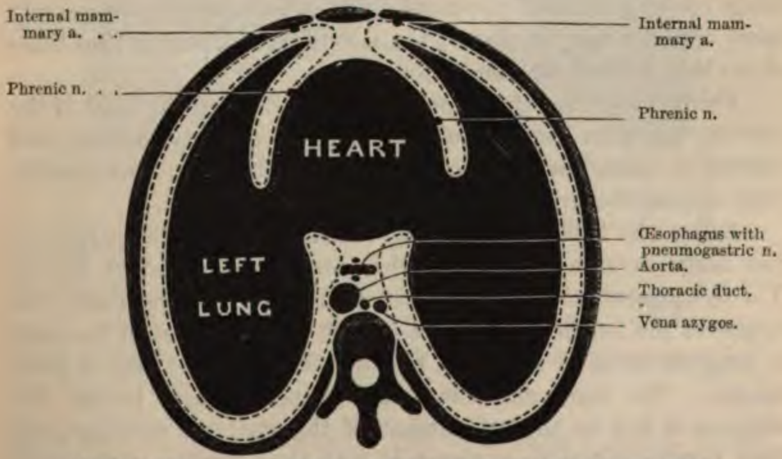


DIAGRAM OF THE REFLECTIONS OF THE PLEURAL SACS IN DOTTED LINES.

The *posterior mediastinum* (fig. 20) contains the œsophagus, the two pneumogastric nerves, the aorta, the thoracic duct, the vena azygos, the trachea, and some lymphatic glands.

The *middle mediastinum* is the largest of the mediastina, and contains the heart with its large vessels and the phrenic nerves.

Before passing to the dissection of the contents of the thorax, the student should carefully trace the outline of the free borders of the pleuræ as seen in the front of the chest. As the margins of the lungs for all practical purposes correspond with the borders of the pleuræ, we shall confine our description to the more important of the two structures, viz. the lungs. The value of this investigation is, that we are enabled to trace upon a living chest the outlines of the lungs, and know what parts are naturally resonant on percussion.

Commencing from above (fig. 21, p. 125) we find that the apex of the lung extends into the neck, from an inch to an inch and a half above the clavicle. This part of the lung ascends behind the subclavian artery and the scalenus anticus muscle, and deserves especial attention, because it is, more than any other, the seat of tubercular disease. From the sternal end of the clavicles the lungs converge towards the middle line, where their borders nearly meet opposite the junction of the second rib. There is thus little or no lung behind the manubrium sterni.

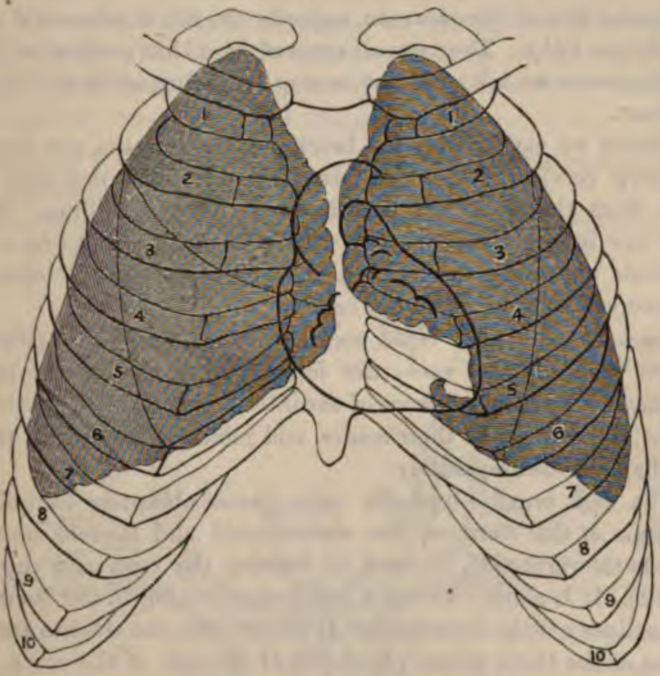
From the level of the second costal cartilage to the level of the fourth, the inner margins of each lung run nearly parallel and almost in contact behind the middle of the sternum; consequently they overlap the great vessels at the root of the heart.

Below the level of the fourth costal cartilage the margins of the lungs diverge from each other, but not in an equal degree. The *left* presents the notch for the heart, and follows nearly the course of the fourth costal cartilage; at the lower part of its curve it projects more or less over the apex of the heart like a little tongue. The *right* descends almost perpendicularly behind the sternum as low as the attachment of the ensiform cartilage, and then turning outwards corresponds with the direction of the sixth costal cartilage. Hypertrophy of the heart, or effusion into the pericardium, will not only raise the point where the lungs diverge above the ordinary level, but also increase their divergence; hence the greater dulness on percussion.

PRÆCORDIAL REGION.

The *præcordial region* is the outline of the heart traced upon the front wall of the chest. It is important for auscultatory purposes that we should know how much of the heart is covered and separated from the wall of the chest by intervening lung (fig. 21). The following will give a fair

FIG. 21.



FORM OF THE LUNGS, AND THE EXTENT TO WHICH THEY OVERLAP THE HEART AND ITS VALVES.

indication. 'Let the middle of the fifth costal cartilage be the centre of a circle two inches in diameter; this circle will define, for all practical purposes, that part of the præcordial region which is naturally less resonant to percussion; here the heart is uncovered except by pericardium and loose cellular tissue, and lies close

behind the thoracic wall. In the rest of the præcordial region the heart is covered and separated from the chest wall by intervening lung.'

Where should we put the stethoscope when we listen to the valves of the heart? For practical purposes it is enough to remember that the mouth of an ordinary-sized stethoscope will cover a portion of them all, if it be placed a little to the left of the mesial line of the sternum opposite the third intercostal space (fig. 21, p. 125). They are all covered by a thin portion of lung; for this reason we ask a patient to stop breathing while we listen to his heart.

Before we can display the brachio-cephalic veins, the layer of the deep cervical fascia must be removed which descends over them from the neck and is lost upon the pericardium. Their coats are intimately connected with this fascia; and one of its functions appears to be to keep the veins permanently open for the free return of blood to the heart.

BRACHIO-CEPHALIC VEINS. The *right* and *left brachio-cephalic* (innominate) *veins* are formed, near the sternal end of the clavicle, by the confluence of the internal jugular and subclavian veins. They differ in their course and relations, and must, therefore, be described separately.

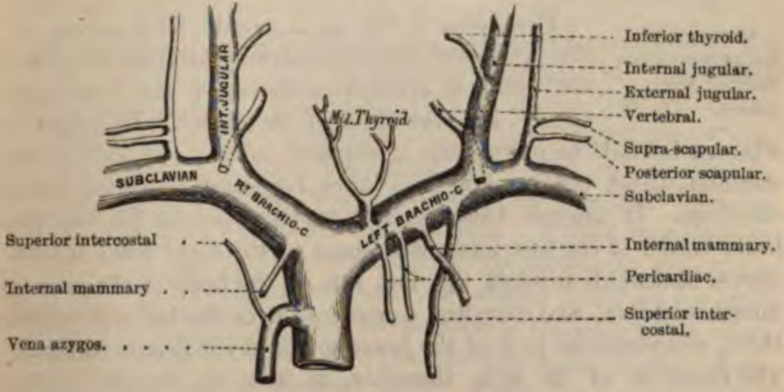
The *left brachio-cephalic vein* passes obliquely behind the first bone of the sternum, the sterno-hyoid and thyroid muscles, towards the right side, to assist in forming the vena cava superior (fig. 22). It is about two and a half inches in length, and its direction inclines a little downwards. It crosses over the trachea and the origins of the three primary branches of the arch of the aorta. We are reminded of this fact in some cases of aneurysm of these vessels —for what happens? The vein becomes compressed between the aneurysm and the sternum; hence the swelling and venous congestion of the parts from which it returns its blood; namely, of the left arm, and the left side of the neck. The upper border of the vein is not far from the upper border of the sternum: in some cases it lies even higher, and we have seen it crossing in front of the trachea fully an inch above the sternum. This occasional

deviation should be borne in mind in the performance of tracheotomy.

The *right brachio-cephalic vein* descends nearly vertically to join the superior vena cava, opposite the first right intercostal space. It is about an inch and a half in length, and is situated about one inch from the mesial line of the sternum. On its left side, but on a posterior plane, runs the arteria innominata; on its right side is the pleura. Between the vein and the pleura is the phrenic nerve. The brachio-cephalic veins are not provided with valves. The veins which generally empty themselves into the right and left brachio-cephalic are as follows:—

The Right B. C. Vein receives:—	The Left B. C. Vein receives:—
The vertebral.	The vertebral.
The deep cervical (not drawn).	The deep cervical (not drawn).
The internal mammary.	The internal mammary.
The middle thyroid (sometimes).	The middle thyroid.
	The superior intercostal.
	The pericardiac.

Fig. 22.



SUPERIOR VENA CAVA AND ITS TRIBUTARIES.

Vena Cava Superior. This is the great vein through which the impure blood from the head, upper extremities, and chest, returns into the right auricle. It is formed by the junction

of the right and left brachio-cephalic veins, which unite at nearly a right angle opposite the first intercostal space on the right border of the sternum; that is, about the level of the highest point of the arch of the aorta. The vena cava descends vertically, with a slight inclination backwards, to the upper and anterior part of the right auricle. It is from two and a half to three inches long. The lower half of it is covered by the pericardium; you must, therefore, open this sac to see how the serous layer of the pericardium is reflected over the front and sides of the vein. In respect to its relations, notice that the vein lies in front of the right bronchus and the right pulmonary vessels; and that it is overlapped by the ascending aorta, which lies to its left side. In the upper half of its course, that is, above the pericardium, it is covered on its right side by the pleura; on this side, in contact with it, descends the phrenic nerve.

Before it is covered by the pericardium, the vena cava receives the right vena azygos, which opens into it after hooking over the right bronchus.

COURSE AND RELATIONS OF THE ARCH OF THE AORTA.

The aorta is the great trunk from which all the arteries of the body carrying arterial blood are derived. It arises from the upper and back part of the left ventricle of the heart. Its origin is situated behind the pulmonary artery and on the left side of the sternum, about the level of the lower border of the third costal cartilage. It ascends forwards and to the right as high as the lower border of the first intercostal space on the right side; it then curves backwards towards the left side of the body of the second dorsal vertebra, and turning downwards over the left side of the third, completes the arch at the lower border of the fourth vertebra. The direction of the arch, therefore, is from the sternum to the spine, and rather obliquely from right to left.

The arch of the aorta presents partial dilatations in certain situations. One of these, called the *great sinus of the aorta*, is observed on the right side of the arch, about the junction of the ascending with the transverse portion: it is little marked

in the infant, but increases with age. Three other dilatations (the *sinuses of Valsalva*), one corresponding to each of the valves at the commencement of the aorta, will be examined hereafter.

For convenience of description, the arch of the aorta is divided into an ascending, a transverse, and a descending portion.

Ascending portion.—To see this portion of the aorta, the pericardium must be opened. You then observe that this part of the artery is enclosed all round by the serous layer of the pericardium, except where it is in contact with the pulmonary artery. It is about two inches in length, and ascends with a slight curve to the upper border of the second costal cartilage of the right side, where it lies almost in contact with the sternum. Its commencement is covered by the pulmonary artery, and overlapped by the appendix of the right auricle. On its right side, but on a posterior plane, descends the superior vena cava; on its left is the division of the pulmonary artery; behind it, are part of the right auricle, the right pulmonary artery and vein and the right bronchus. This part of the aorta gives off the right and left coronary arteries for the supply of the heart.

Transverse portion.—This portion of the aorta arches from the front to the back of the thorax, and extends from the upper border of the second right costal cartilage to the left side of the second dorsal vertebra. In front, it is covered by the left pleura, and is crossed by the left phrenic, the left pneumogastric, the superficial cardiac nerves, and the pericardiac veins. Near its summit runs the left brachio-cephalic vein. Within its concavity are the left bronchus, the bifurcation of the pulmonary artery, the left recurrent laryngeal nerve, and the remains of the ductus arteriosus. The artery rests upon the trachea (a little above its bifurcation), the deep cardiac plexus, the œsophagus, the thoracic duct, and the left recurrent laryngeal nerve. From the transverse part of the arch arise the arteria innominata, the left carotid, and the left subclavian arteries.

Descending portion.—This part of the arch lies upon the left side of the body of the third dorsal vertebra, and at the lower border of the body of the fourth dorsal it takes the name of the

descending thoracic aorta. On its right side are the œsophagus and thoracic duct; on its left is the pleura; in front is the root of the left lung.

What parts are contained within the arch of the aorta?—The left bronchus, the right pulmonary artery, the left recurrent nerve, the remains of the ductus arteriosus, and the superficial cardiac plexus of nerves.

RELATIONS OF THE ARCH OF THE AORTA TO THE STERNUM.

These relations vary according to the size of the heart, the obliquity of the ribs, and the general development of the chest. In a well-formed adult the ascending aorta is, at the most prominent part of its bulge, about half an inch behind the first bone of the sternum. The highest part of the arch is about one inch below the upper edge of the sternum.*

From the upper part of the arch arise three large arteries for the head, neck, and upper limbs; namely, the brachio-cephalic or innominate artery, the left carotid, and the left subclavian.

BRACHIO-CEPHALIC OR INNOMINATE ARTERY.

This, the largest of the three, arises from the commencement of the transverse part of the arch. It ascends obliquely towards the right, and after a course of about one inch and a half to two inches divides behind the right sterno-clavicular joint into two arteries of nearly equal size—the right subclavian and the right carotid.

The relations of the b. c. artery are as follow. It lies behind the first bone (manubrium) of the sternum and the right sterno-clavicular joint. It ascends obliquely (towards the right) in front of and close to the trachea. On its right side, and close to it, is the right b. c. vein. On its left is the left carotid a. In front of it are the left b. c. vein, the sterno-hyoid and sterno-thyroid m.

* The relations of the arch of the aorta to the sternum vary even in adults, more especially if there be any hypertrophy of the heart. As an instance among many, we may mention that of a young female who died of phthisis. The position of the aortic valves was opposite the middle of the sternum, on a level with the middle of the second costal articulation. The highest part of the arch was on a level with the upper border of the sternum; the arteria innominata was situated entirely in front of the trachea; and the left brachio-cephalic vein crossed the trachea so much above the sternum that it would have been directly exposed to injury in tracheotomy.

Parallel with, and close to, the artery are the slender cardiac nerves.*

With the anatomy of the parts before you, you can understand that an aneurysm of the innominate artery might be distinguished from an aneurysm of the aorta—1. By a pulsation in the neck between the sterno-mastoid muscles, i.e. in the fossa above the sternum; 2. By occasional dyspnœa owing to pressure on the trachea; 3. By venous congestion in the *left* arm; 4. By the aneurysmal thrill being confined to the *right* arm.†

LEFT CAROTID ARTERY. This artery arises from the arch of the aorta close to, and to the left of, the arteria innominata. It ascends obliquely behind the first bone of the sternum, and the sterno-hyoid and thyroid muscles, to the neck. In the first part of its course it lies upon the trachea, but it soon passes to the left side of the trachea, and then lies for a short distance upon the œsophagus and thoracic duct. It is crossed by the left brachio-cephalic vein; on its left side are the left subclavian artery and pneumogastric nerve; on the right side is the arteria innominata. In the rest of its course it resembles the right carotid (p. 32).

LEFT SUBCLAVIAN ARTERY. This is the third branch of the arch. It ascends nearly vertically out of the chest to the inner border of the first rib, and then curves outwards behind the scalenus anticus. In the first part of its course it is deeply seated, and is covered on its left side by the pleura. Close to its right side are the left carotid, the trachea and œsophagus; between the

* In some cases the innominate artery ascends for a short distance above the clavicle before it divides, lying close to the right of the trachea. We have already alluded to the fact that it occasionally gives off a middle thyroid artery (p. 37), which ascends in front of the trachea to the thyroid body, and is therefore directly in the way in tracheotomy.

† If the innominate artery be ligatured, the circulation would be maintained by the following collateral branches:—1. Between the branches of the two external carotids, which anastomose across the middle line. 2. Between the aortic intercostal and the superior intercostal. 3. Between the aortic intercostals and the internal mammary, long thoracic, alar thoracic, and subscapular arteries. 4. Between the internal mammary and deep epigastric. 5. Between the inferior thyroid arteries. 6. Between the two vertebrals. 7. Between the two internal carotid arteries.

artery and the œsophagus is the thoracic duct. Like the other primary branches of the arch, it is crossed by the left brachio-cephalic vein. It is covered in front by the left lung, and it rests upon the longus colli. Anterior to the artery also are the pneumo-gastric, the phrenic, and the cardiac nerves. The upper part of its course, where the vessel passes in front of the apex of the lung, has been described with the anatomy of the neck (p. 62).

COURSE OF THE PHRENIC NERVES THROUGH THE CHEST.

The *phrenic nerve* comes from the third, fourth and fifth cervical nerves. It descends over the scalenus anticus, and enters the chest between the subclavian vein and artery. It then crosses over the internal mammary artery and runs in front of the root of the lung between the pleura and the pericardium to the diaphragm (fig. 23), to the under surface of which it is distributed.*

The phrenic nerve is joined on the scalenus anticus by an offset from the fifth cervical branch of the brachial plexus; by another filament from the sympathetic nerve; and very frequently by a small loop from the nerve to the subclavius muscle; occasionally also by a branch from the descendens noni.

In what respects do the phrenic nerves differ from each other in their course?—The right phrenic runs along the outer side of the brachio-cephalic vein and superior vena cava; the left crosses in front of the transverse part of the arch of the aorta; besides which, the left is rather longer than the right, since it curves over the apex of the heart.

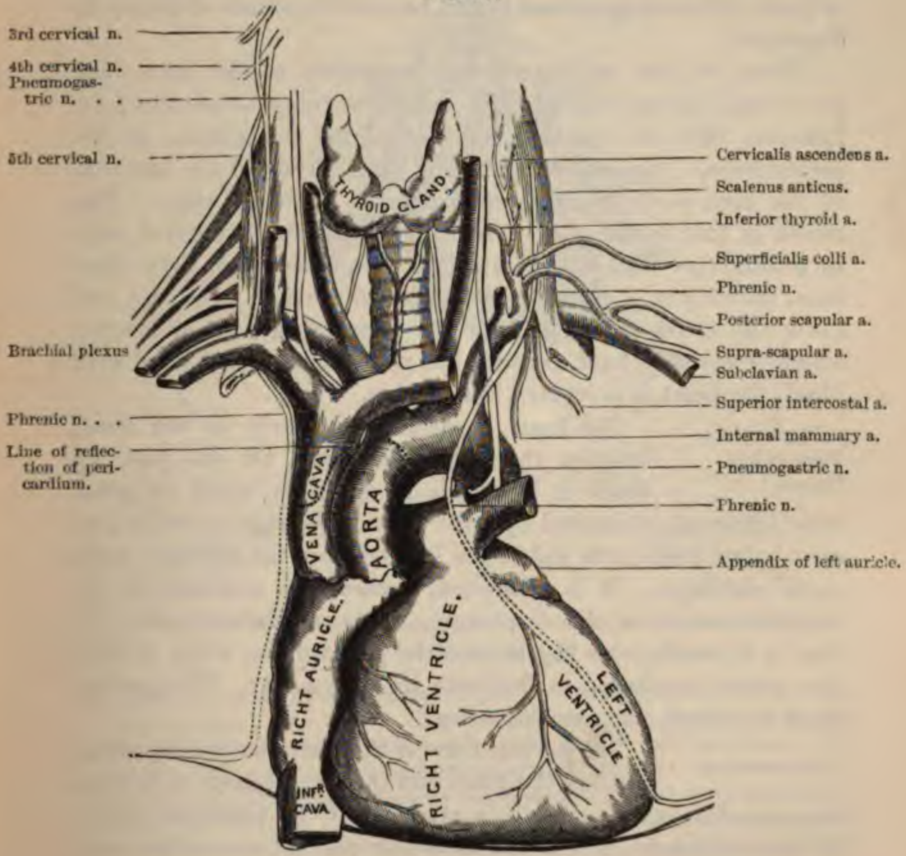
Before the phrenic nerve divides into branches to supply the diaphragm, it sends off minute filaments to the pleura and the pericardium.

Having studied these anatomical details, consider for a moment what symptoms are likely to be produced by an aneurysm of the arch of the aorta, or any of the primary branches. A glance at the important parts in the neighbourhood helps to answer the question. The effects will vary according to the part of the artery which

* In the Museum of the College of Surgeons there is a dissection showing that the right phrenic nerve enters the diaphragm close to the right side of the vena cava inferior, while the left phrenic enters the left muscle of the diaphragm.

is the seat of the aneurysm, and according to the size, the form, and the position of the tumour. One can understand that compression of the vena cava superior, or either of the brachio-cephalic

FIG. 23.



veins, would occasion congestion and œdema of the parts from which they return the blood; that compression of the trachea or one of the bronchi might occasion dyspnœa, and thus simulate

disease of the larynx; * that compression of the œsophagus would give rise to symptoms of obstruction. Nor must we forget the immediate vicinity of the thoracic duct and the recurrent nerve,† and the effects which would be produced by their compression. Can one, then, be surprised that a disease which may give rise to so many different symptoms should be a fertile source of fallacy in diagnosis?

Thus you can understand how aneurysms of the aorta may prove fatal, by bursting into the contiguous tubes or cavities; for instance, into the trachea, the œsophagus, the pleura, or the pericardium. You will see, too, why an aneurysm of the first part of the arch is so much more dangerous than elsewhere. The reason is, that in this part of its course the aorta is covered only by a thin layer of serous membrane. If an aneurysm take place here, the coats of the vessel soon become distended, give way, and allow the blood to escape into the pericardium; an occurrence which is speedily fatal, because, the pericardium being filled with blood, the heart is prevented from acting.

POSITION AND FORM OF THE HEART.

The heart is situated obliquely in the chest, between the lungs. Its base, i.e. the part by which it is attached, and from which its great vessels proceed, is directed upwards towards the right shoulder; its apex points downwards and to the left, between the fifth and sixth costal cartilages. It is supported, towards the abdomen, by the tendinous centre of the diaphragm. It is maintained in its position by a membranous bag termed the pericardium, which is lined by a serous membrane to facilitate its movements. The pericardium must first claim our attention.

PERICARDIUM.

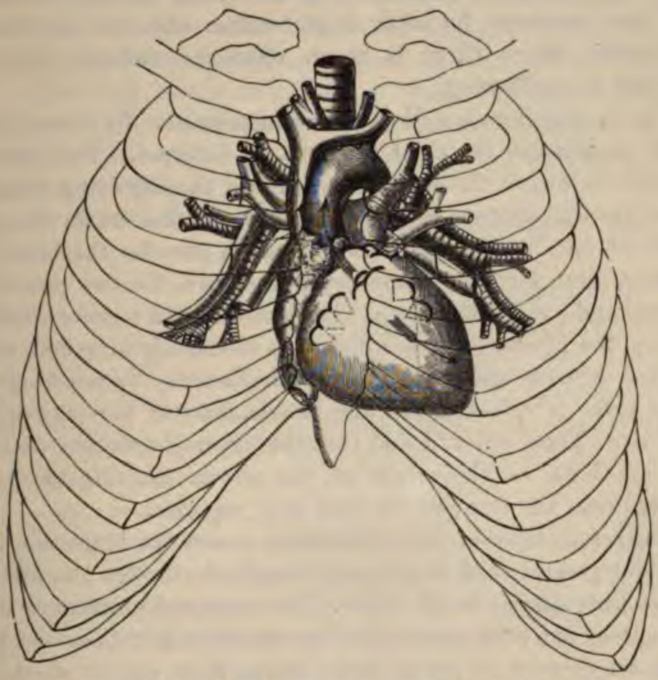
The *pericardium* is the membranous bag which encloses the heart and the large vessels at its base. It is broadest below, where it is attached to the tendinous centre of the diaphragm, and to the muscular part in connection with

* In the Museum of Guy's Hospital there is a preparation, No. 1487, in which laryngotomy was performed under the circumstances described in the text.

† See 'Med. Gaz.,' Dec. 22nd, 1843. A case in which loss of voice was produced by the pressure of an aneurysmal tumour upon the left recurrent nerve.

the tendon; above, it is prolonged over the great vessels of the heart, and is connected with the deep cervical fascia. On each side,

Fig. 24.



RELATIVE POSITION OF THE HEART AND ITS VALVES WITH REGARD TO THE WALLS OF THE CHEST.

The valves are denoted by curved lines. The *aortic valves* are opposite the third intercostal space on the left side, close to the sternum. The *pulmonary valves* are just above the aortic, opposite the junction of the third rib with the sternum. The *mitral valves* are opposite the third intercostal space, about one inch to the left of the sternum. The *tricuspid valves* lie behind the middle of the sternum, about the level of the fourth rib. *Aortic murmurs*, as shown by the arrow, are propagated up the aorta: *mitral murmurs*, as shown by the arrow, are propagated towards the apex of the heart.

it is in contact with the pleura; the phrenic nerve running down between them. In front of it, is the anterior mediastinum; behind

it, is the posterior. Of the objects in the posterior mediastinum, that which is nearest to the pericardium is the œsophagus. It should be remembered that the œsophagus is in close contact with the back of the pericardium and left auricle for nearly two inches; this fact accounts for what is sometimes observed in cases of pericarditis where there is much effusion; namely, pain and difficulty in swallowing.

The pericardium is a *fibro-serous* membrane. Its *fibrous* layer, which constitutes its chief strength, is external. This layer is attached, below, to the central tendon and the adjoining muscular part of the diaphragm. Above, it forms eight sheaths for the great vessels at the base of the heart; namely, one for the vena cava superior, four for the pulmonary veins, two for the pulmonary arteries, and one for the aorta. The *serous* layer forms a shut sac. It lines the fibrous layer to which it is intimately attached, and is reflected over the great vessels and the heart. To see where the serous layer is reflected over the vessels, distend the pericardium with air. Thus you will find that this layer is reflected over the aorta as high as the origin of the arteria innominata. It is reflected over the front of the vena cava superior.

The serous layer of the pericardium covers the large vessels to an extent greater than is generally imagined; though the extent is not precisely similar in all bodies. The aorta and pulmonary artery are enclosed in a complete sheath, two inches in length, so that these vessels are covered all round by the serous layer, except where they are in contact. Indeed you can pass your finger behind them both, through a foramen bounded, in front, by the two great vessels themselves, behind, by the upper part of the auricles, and above, by the right pulmonary artery. Again, the back of the aorta, where it lies on the auricles, is covered by the serous pericardium. The superior cava is covered all round, except behind, where it crosses the right pulmonary artery. The inferior cava within the pericardium is partly covered in front. The left pulmonary veins are covered nearly all round; the right less so. Behind the auricles, chiefly the left, the serous layer extends upwards in the form of a pouch, rising above their upper border, so as to be loosely

connected to the left bronchus. The object of these serous reflections is to facilitate the free action of the heart and the great vessels at its base.

In the healthy state, the capacity of the pericardium nearly corresponds to the size of the heart when distended to its utmost. The healthy pericardium, with the heart *in situ*, may be made to hold, in the adult, about ten ounces of fluid. The pericardium is not extensile. When an aneurysm bursts into it, death is caused, not by loss of blood, but by compression of the heart in consequence of the inextensibility of the pericardium.

The pericardium derives its blood from the internal mammary, bronchial, and œsophageal arteries.

On separating the left pulmonary artery and pulmonary vein, you will notice a fold of serous membrane about three-quarters of an inch long and about one inch in depth: this is the *vestigial fold of the pericardium*, described by Marshall.* It passes from the side of the left auricle to the left superior intercostal vein. It is a vestige of the left v. c. superior which exists in fœtal life.

Open the pericardium, and observe that the heart is conical in form, and convex everywhere except upon its lower surface, which is flat, and rests upon the tendinous centre of the diaphragm. When the pericardium is thus laid open, the following objects are exposed: viz. 1. Part of the right ventricle; 2. Part of the left ventricle; 3. Part of the right auricle with its appendix overlapping the root of the aorta; 4. The appendix of the left auricle overlapping the root of the pulmonary artery; 5. The aorta; 6. The pulmonary artery; 7. The vena cava superior; 8. The right and left coronary arteries.

POSITION OF THE HEART—CONTINUED.

The heart then, placed behind the lower half of the sternum, occupies more of the left than the right half of the chest, and rests upon the tendinous centre of the diaphragm, which is a little below the lowest part of the fifth rib. At each contraction the apex of the heart may be felt beating between the cartilages of the fifth

* 'Philosoph. Transactions,' 1850.

and sixth ribs, about two inches below the nipple and an inch to its sternal side. Speaking broadly, the base corresponds with a line drawn across the sternum along the upper borders of the third costal cartilages. The right border of the heart is formed almost entirely by the free margin of the right auricle, and, when distended, bulges nearly an inch to the right of the sternum. The left border of the heart is formed by the round border of the left ventricle, and reaches from a point, commencing at the second left intercostal space, to a point placed two inches below the nipple and an inch to its sternal side. The horizontal border is formed by the sharp margin of the right ventricle, and extends from the sternal attachment of the fifth right costal cartilage, to meet the lowest point of the left margin.

The normal position which the cardiac valves hold to the thoracic walls is difficult to define with precision, and this probably accounts for the discrepancies noticed in anatomical works on this subject. The following relations are the results of carefully made observations in the 'post-mortem' room: The *right auriculo-ventricular valves* are situated behind the sternum about the level of the fourth costal cartilage: the *left auriculo-ventricular valves* are opposite the third intercostal space, about one inch to the left of the sternum; the cusps of these valves extend as low as the fifth costal cartilage. The *pulmonary valves* lie immediately behind the junction of the third left costal cartilage with the sternum; the *aortic valves* are behind the upper border of the third intercostal space just at the left side of the sternum.

The position of the heart varies a little with the position of the body. Of this anyone may convince himself by leaning alternately forwards and backwards, by lying on this side and on that, placing at the same time his hand upon the præcordial region. He will find that he can, in a slight degree, alter the place and the extent of the impulse of the heart. Inspiration and expiration also alter the position of the heart. In inspiration the heart descends with the tendinous centre of the diaphragm about half an inch.

PLEURA. As the lungs are continually gliding to and fro, within the chest, they are provided with a serous membrane to facilitate their motion. This membrane is termed the pleura. There is one for each lung. Each pleura forms a completely closed sac, and, like all other serous sacs, has a *parietal* and a *visceral layer*; that is, one part of the sac lines the containing cavity, the other is reflected over the contained organ. Its several parts are named after the surface to which they adhere: that which lines the ribs is called *pleura costalis*; that which covers the lung, *pleura pulmonalis*. Unlike the peritoneum, the pleura forms no folds except a small one called *ligamentum latum pulmonis*, which extends from the root of the lung to the diaphragm.

The pleural sac (fig. 20, p. 123) lines the ribs and part of the sternum; from the sternum it is reflected backwards over the pericardium; from thence it passes over the front of the root of the lung, and so on over the entire lung to the back part of its root, whence it is reflected over the sides of the vertebræ, and thus reaches the ribs and the diaphragm.

The thickness of the pleura differs; on the lung it is thin, semi-transparent, and firmly adherent; on the ribs and diaphragm it is thick, and may be easily separated from its osseous and muscular connections.

The spaces called *anterior* and *posterior mediastina*, formed by the separation of the pleuræ, have been already described, p. 123.

In health the internal surface of the pleura is smooth, polished, and lubricated by moisture sufficient to facilitate the sliding of the lung.* When this surface is thickened and roughened by inflammation, the moving lung produces a friction sound. When the pleural sac is distended by serum, it constitutes hydro-thorax; when by pus, empyema; when by air, pneumo-thorax; when by blood, hæmo-thorax.

* The pleura costalis is covered with flattened epithelial cells; the pleura pulmonalis with polyhedral granular cells. (Klein.)

Introduce your hand into the pleural sac, and ascertain that the reflection of the pleura on to the diaphragm corresponds with an imaginary line commencing at the lower part of the sternum, and sloping along the cartilages of the successive ribs down to the lower border of the last rib. Supposing a ball to lodge in the pleural sac, it might fall upon the dome of the diaphragm, and roll down to the lowest part of the pleural cavity. The place, therefore, to extract it, would be in the back, at the eleventh intercostal space. This operation has been done during life with success.

POSITION AND FORM OF THE LUNGS.

The lungs are situated in the chest, one on each side of the heart. Each fits accurately into the cavity which contains it. Each, therefore, is conical in form; the base rests on the diaphragm; the apex projects into the root of the neck a little more than an inch above the sternal end of the clavicle. Its outer surface is adapted to the ribs; its inner surface is excavated to make room for the heart. The best way to see the shape of the lungs is to inject them through the trachea with wax, which is tantamount to taking a cast of each thoracic cavity. In such a preparation, besides the general convexities and concavities alluded to, you would find in the right lung a little indentation for the right brachio-cephalic vein, in the left an indentation for the arch of the aorta and the left subclavian artery.

Each lung is divided into an *upper* and a *lower lobe* by a deep fissure, which commences, behind, about three inches from the apex, and proceeds obliquely downwards and forwards to the junction of the 6th rib with its cartilage (fig. 21). Speaking broadly, nearly the whole of the anterior portion of the lung is formed by the upper lobe; nearly the whole of the posterior portion by the lower lobe. It should be noticed, however, that the upper lobe of the right lung is divided by a second fissure which marks off, from its lower part, a triangular portion called its *middle lobe*.

The dimensions of the right lung are greater than those of the left in all directions except the vertical; the reason of this exception is the greater elevation of the diaphragm on the right side

by the liver. On an average, the right lung weighs 24 ounces; the left 21 ounces.

Posterior Mediastinum and its Contents. The posterior mediastinum (p. 123) is formed by the reflection of the pleural sac on each side, from the root of the lung to the sides of the bodies of the dorsal vertebræ. It is bounded in front by the pericardium. To obtain a view of it, draw out the right lung, and fasten it to the left side. This mediastinum contains the descending thoracic aorta; in front of the aorta, the œsophagus, with the pneumogastric nerves; on the right of the aorta is the vena azygos; between this vein and the aorta is the thoracic duct; superiorly is the trachea; inferiorly are the splanchnic nerves and some lymphatic glands. To expose these last, we must remove the pleura, and a layer of dense fascia which lines the chest outside it.

Descending Thoracic Aorta. We have already traced the arch of the aorta to the lower border of the body of the fourth dorsal vertebra (p. 129). From this point, the aorta descends on the left side of the spine, gradually approaching towards the middle line. The artery, moreover, following the dorsal spinal curve is not vertical, but concave forwards. Opposite the last dorsal vertebra it passes between the crura of the diaphragm and enters the abdomen. Its left side is covered by pleura; on its right run the vena azygos, the œsophagus, and thoracic duct; in front of it are, the root of the left lung, and the pericardium. Lower down the œsophagus is in front of the artery, and subsequently lies a little to its left side. Its branches will be described presently.

Vena Azygos, Major and Minor. This vein commences in the abdomen by small branches from one of the lumbar veins of the right side, and generally communicates with the renal, or the vena cava itself. This, indeed, is the main point about the origin of the vena azygos, that it communicates directly or indirectly with the vena cava inferior. It enters the chest through the aortic opening of the diaphragm, and ascends on the right side of the aorta through the posterior mediastinum, in front of the bodies of the lower dorsal vertebræ, and over the right

intercostal arteries. When the vein reaches the level of the third dorsal vertebra, it arches over the right bronchus, and terminates in the superior vena cava, just before this vessel is covered by pericardium. In its course it receives all the right intercostal veins, the spinal veins, the œsophageal and commonly the right bronchial vein. Opposite the sixth or seventh dorsal vertebra it is joined by the left vena azygos.

Fig. 25.

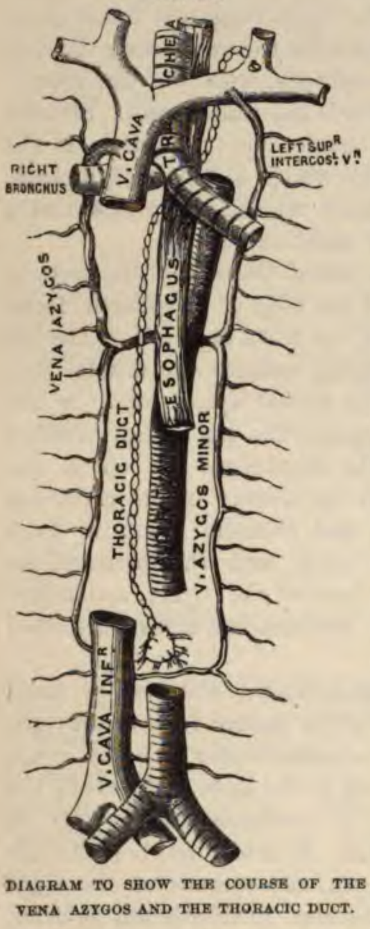


DIAGRAM TO SHOW THE COURSE OF THE VENA AZYGOS AND THE THORACIC DUCT.

The left vena azygos, *vena azygos minor*, runs up the *left* side of the spine. This vein commences in the abdomen from one of the lumbar veins of the left side, or from the left renal. It then ascends on the left side of the aorta, through the aortic opening in the diaphragm. On a level with the sixth or seventh dorsal vertebra, it passes beneath the aorta and thoracic duct to join the azygos major. Before passing beneath the aorta it usually communicates with the left superior intercostal vein. It generally receives six or seven of the lower intercostal veins of the left side. These azygos veins are provided with imperfect valves, and are supplemental to the inferior vena cava.

Thoracic Duct and Receptaculum Chyli. The *thoracic duct* (figure 25) is a canal about eighteen inches long, through which the contents of the lacteal vessels from the intestines and the lymphatics from the lower limbs

are conveyed into the blood. These vessels converge to a general receptacle, termed *receptaculum chyli*, situated in front of the body of the second lumbar vertebra. From this dilatation, the duct ascends at first behind the aorta. Then getting to its right side, it passes through the aortic opening of the diaphragm into the chest, and runs up the posterior mediastinum, still along the right side of the aorta, between this vessel and the vena azygos major. Near the *third* dorsal vertebra, it passes behind the arch of the aorta and the œsophagus, and ascends on the left side of this tube, between it and the left subclavian artery, as high as the seventh cervical vertebra, where it describes a curve with the convexity upwards, and opens in front of the scalenus anticus into the back part of the confluence of the left internal jugular and subclavian veins. The orifice of the duct is guarded by two valves which permit fluid to pass from the duct into the vein, but not *vice versâ*. Valves, disposed like those in the venous system, are placed at short intervals along the duct, so that its contents can only pass upwards.* The diameter of the duct varies in different parts of its course; at its commencement it is about three lines in diameter, at the sixth dorsal it is about two lines, and it enlarges again towards the termination. It receives the lymphatics from the lower extremities, and from all the abdominal viscera (except the convex surface of the liver and the abdominal walls), above these it receives the lymphatics from the left side of the thorax, the left lung, the heart, the left upper extremity, and the left side of the head and neck.

ŒSOPHAGUS.

The *œsophagus* is that part of the alimentary canal which conveys the food from the pharynx to the stomach. It commences at the lower border of the fifth cervical vertebra, at the back of the cricoid cartilage; runs down

* It is right to state that the thoracic duct varies in size in different individuals. It may divide in its course into two branches, which subsequently reunite; instead of one, there may be several terminal orifices. Instances have been observed in which the duct has terminated on the right instead of the left side (Fleischmann, 'Leichenöffnungen,' 1815; also Morrison, 'Journal of Anat.,' vol. vi. p. 427). It has been seen to terminate in the vena azygos (Müller's 'Archiv,' 1834).

first to the right side of the transverse portion of the arch of the aorta, then through the posterior mediastinum in front of the descending aorta, and passes through the œsophageal opening in the diaphragm to the stomach. It is from nine to ten inches long. Its course is not exactly straight; in the neck, it lies behind and a little to the left of the trachea; in the chest, i.e. about the fourth dorsal vertebra, it inclines towards the right side, to make way for the aorta; but it again inclines to the left before it passes through the diaphragm. It has moreover an antero-posterior curve corresponding to the curve of the spine.

The œsophagus, in the first part of its course, rests upon the longus colli muscle, then upon the thoracic duct and the third, fourth, and fifth intercostal vessels of the right side, and, lastly, it lies in front, and slightly to the left side, of the aorta. In front of it is the trachea and the left bronchus. Before it passes through the diaphragm it lies in close contact with the pericardium (behind the left auricle) for nearly two inches; this accounts for the pain which is sometimes experienced in cases of pericarditis, during the passage of food.

In the neck, the œsophagus is in connection, laterally, with the thyroid body, the common carotid and inferior thyroid arteries, and the recurrent laryngeal nerves; to the left of it is the thoracic duct. In the thorax the aorta is to the left, and the vena azygos major to the right, of the tube. As it passes down in the inter-pleural space, it is in connection with both pleuræ. The œsophagus is surrounded by a plexus of nerves, formed by the pneumogastric nerves, the left being in front, the right behind it.

The œsophagus is supplied with blood by the inferior thyroid, the œsophageal branches of the aorta, the coronaria ventriculi, and the left phrenic artery. It is supplied with nerves by the pneumogastric and the sympathetic, which ramify between the two muscular layers. The œsophagus is composed of three coats, an external or muscular, a middle or areolar, and an internal or mucous. The muscular coat consists of an outer longitudinal and an inner circular layer of fibres. The longitudinal layer is particularly strong, and arranged in the upper part mainly in three

bundles, an anterior and two lateral; these, lower down, spread out and form a continuous layer round the œsophagus and support the circular fibres. Under the microscope the muscular fibres composing the upper part are seen to consist entirely of the striped variety; at the lower part, almost exclusively of the non-striped variety. The middle coat is composed of areolar tissue, and connects very loosely the muscular and mucous coats. The mucous membrane is of a pale colour and considerable thickness, and in the contracted state of the œsophagus is arranged in longitudinal folds within the tube which lies flattened in front of the spine. On the surface of the mucous membrane there are numerous minute papillæ placed obliquely. It is lined by a very thick layer of scaly epithelium. In the submucous tissue are many small compound racemose glands—*œsophageal glands*—especially towards the lower end of the œsophagus.

Course and Branches of the Pneumogastric Nerves.

The *right* pneumogastric nerve enters the chest between the subclavian artery and vein, descends by the side of the trachea, then passes behind the root of the right lung to the posterior surface of the œsophagus, upon which it divides into branches, which form a plexus (posterior œsophageal) upon that tube. The plexus then reunites into a single trunk, which passes into the abdomen through the œsophageal opening in the diaphragm. The *left* pneumogastric descends into the chest between the left subclavian and carotid arteries, and behind the left brachio-cephalic vein. It then crosses in front of the arch of the aorta, and passes behind the root of the left lung to the anterior surface of the œsophagus, upon which it also forms a plexus (anterior œsophageal). The branches of the pneumogastric nerve in the chest are as follows:—

a. The inferior laryngeal or recurrent.—This nerve on the right side turns under the subclavian and the common carotid arteries (p. 61); on the left, under the arch of the aorta, below the ductus anteriosus, and ascends to the larynx. It passes beneath the inferior thyroid artery, and lying in the groove between the trachea and œsophagus, it enters the larynx beneath the lower border of the inferior constrictor of the

pharynx. It supplies with motor nerves all the muscles which act upon the rima glottidis, except the crico-thyroid (supplied by the external laryngeal nerve). As they turn beneath their respective arteries, they give off branches to the deep cardiac plexus.

b. Cardiac branches.—These are very small, and join the cardiac plexuses; the right arise from the right recurrent laryngeal and the right pneumogastric, close to the trachea; the left come from the left recurrent laryngeal nerve. On both sides these branches pass to the deep cardiac plexus.

c. Pulmonary branches.—These accompany the bronchial tubes. The greater number run behind the root of the lung, and constitute the *posterior* pulmonary plexus. A few, forming the *anterior* pulmonary plexus, supply the front part of the root of the lung. Both these plexuses are joined by filaments from the sympathetic system. The nerves of the lungs are, however, very small, and cannot be traced far into their substance.*

d. Œsophageal plexus.—Below the root of the lung each pneumogastric nerve is subdivided so as to form an interlacement of nerves round the œsophagus (plexus gulæ). From this plexus numerous filaments supply the coats of the tube; but the majority of them are collected into two nerves—the one, the continuation of the left pneumogastric nerve lying in front of the œsophagus; the other, that of the right, lying behind it. Both nerves pass through the œsophageal opening in the diaphragm for the supply of the stomach.

Having examined the contents of the posterior mediastinum from the right side, now do so from the left. The left lung should be turned out of its cavity and fastened by hooks towards the right side. After removing the pleura, we see the descending thoracic aorta, the pneumogastric nerve crossing the arch and sending the recurrent branch under it; also the first part of the left subclavian, covered externally by the pleura. The pneumogastric nerve must be traced behind the root of the left lung to the œsophagus, and the œsophageal plexus of this side dissected. Lastly, notice the lesser vena azygos which crosses under the aorta about the sixth or seventh dorsal vertebra to join the vena azygos major.

* Upon this subject, see the beautiful plates of Scarpa.

Thoracic Portion of the Sympathetic. This portion of the sympathetic system is generally composed of twelve ganglia covered by the pleura; one ganglion being found over the head of each rib. Often there are only ten ganglia, in consequence of two of them uniting here and there. The first thoracic ganglion is the largest.

Fig. 26.

DIAGRAM OF THE THORACIC PORTION OF THE SYMPATHETIC.

Each ganglion is connected by two branches with the corresponding intercostal nerve. The nerves proceeding from the ganglia pass inwards to supply the thoracic and part of the abdominal viscera. The branches which proceed from the four upper ganglia are small and are distributed as follows (see the diagram):—

a. Minute nerves from the first and second ganglia to the deep *cardiac plexus.*

b. Minute nerves from the third and fourth ganglia to the *posterior pulmonary plexus.*

The branches arising from the six lower ganglia unite to form three nerves —the *great splanchnic*, the *lesser*, and the *smallest splanchnic nerves.*

a. The *great splanchnic* nerve is generally formed by branches from the fifth or sixth to the tenth ganglion. They descend obliquely along the sides of the bodies of the dorsal vertebræ, and unite into a single nerve, which passes through the corresponding crus of the diaphragm, and joins the semilunar ganglion of the abdomen, sending also branches to the renal and supra-renal plexuses.

b. The *lesser splanchnic* nerve is commonly formed by branches from the eleventh and twelfth ganglia. It passes through the

crus of the diaphragm to the cœliac plexus, and occasionally to the renal plexus.*

c. The *smallest splanchnic* nerve (when present) comes from the twelfth ganglion, passes through the crus of the diaphragm, and terminates in the renal and cœliac plexuses. (This is not represented in the diagram.)

INTERCOSTAL MUSCLES. The intercostal muscles occupy the intervals between the ribs. In each interval there are two layers of muscles which cross like the letter X. The *external intercostals* run obliquely from behind forwards, like the external oblique muscle of the abdomen. The *internal* run from before backwards, like the internal oblique. Observe that a few fibres of the inner layer pass over one or even two ribs, chiefly near the angles, and more especially of the lower ribs, and terminate upon a rib lower down.†

Neither of these layers of intercostal muscles extends all the way between the sternum and the spine: the outer layer, beginning at the spine, ceases at the cartilages of the ribs; the inner, commencing at the sternum, ceases at the angles of the ribs.

The intercostal muscles present an intermixture of tendinous and fleshy fibres; and they are covered inside and outside the chest by a glistening fascia, to give greater protection to the intercostal spaces.

The external intercostal muscles elevate the ribs, and are therefore muscles of inspiration. The internal intercostal muscles depress the ribs, and are therefore muscles of expiration.

INTERCOSTAL ARTERIES. There are twelve intercostal arteries on each side, which lie between the internal and external intercostal muscles, the last excepted. The *two upper* arteries are supplied by the intercostal branch of the subclavian; the remaining *ten* are furnished by the aorta: and since this vessel lies rather on the left side of the spine, the right intercostal arteries are longer than the left. The upper intercostal arteries from the aorta ascend

* In a few instances we have traced a minute filament from one of the ganglia into the body of a vertebra. According to Cruveilhier each vertebra receives one.

† These irregular muscular bundles are called the *subcostal muscles*.

obliquely to reach their intercostal spaces; the lower run more transversely. As they pass outwards, they are covered by the pleura and the sympathetic nerves; the right, in addition, pass behind the œsophagus, thoracic duct, and the vena azygos major. Having reached the intercostal space, each artery divides into an *anterior* and a *posterior* branch. The *anterior* branch in direction and size appears to be the continuation of the common trunk. At first it runs *along the middle of the intercostal space,* lying upon the external intercostal muscle, and separated from the cavity of the chest by the pleura and intercostal fascia. Here, therefore, it is liable to be injured by a wound in the back. But near the angle of the rib it passes between the intercostal muscles, and occupies the groove in the lower border of the rib above. Here it gives off a small branch, the *collateral intercostal,* which runs for some distance along the upper border of the rib below. After supplying the muscles, the main trunk anastomoses with the anterior intercostal branch of the internal mammary artery. In some cases this branch is as large as the intercostal itself, and situated so as to be directly exposed to injury in the operation of tapping the chest.

In its course along the intercostal space, each artery sends branches to the intercostal muscles and the ribs. About midway between the sternum and the spine, each gives off a small branch, which accompanies the lateral cutaneous branch of the intercostal nerve. The continued trunk, gradually decreasing in size, becomes very small towards the anterior part of the space, and is placed more in the middle of it. Those of the true intercostal spaces inosculate with branches of the internal mammary, and thoracic branches of the axillary; those of the false run between the layers of the abdominal muscles, and anastomose with the epigastric and lumbar arteries.

The *posterior* or *dorsal* branch passes backwards between the transverse processes of the vertebræ, on the inner side of the anterior costo-transverse ligament, and is distributed to the muscles and skin of the back. Each sends an artery through the intervertebral foramen to the spinal cord and its membranes.

On the right side the intercostal veins terminate in the vena

azygos major; on the left, the seven or eight lower terminate in the vena azygos minor, the remainder in the left superior intercostal vein.

The usual relation which the intercostal vessels and nerve bear to each other in the intercostal space, is, that the vein lies uppermost, the nerve lowest, and the artery between them.

INTERCOSTAL NERVES. These are twelve in number, and are the anterior divisions of the dorsal spinal nerves. Each dorsal nerve (like all the spinal nerves) arises from the spinal cord by two roots, an anterior or motor, and a posterior or sensory. The sensory root has a ganglion upon it. The two roots unite in the intervertebral foramen and form a *compound* nerve. After passing through the foramen, it is connected by two filaments with the sympathetic nerve, and then divides into an *anterior* and a *posterior* branch. The *posterior* branches pass backwards between the transverse processes of the dorsal vertebræ, and supply the muscles of the back. The *anterior* branches (the proper *intercostal* nerves) proceed between the intercostal muscles in company with, and immediately below, their corresponding arteries. In the anterior part of the intercostal space the nerves lie in the substance of the internal intercostal muscles, and at the costal cartilages run through the muscles, passing in front of the triangularis sterni and the internal mammary artery. Midway between the spine and the sternum, they give off *lateral cutaneous branches*, which supply the skin over the scapula and the thorax. The intercostal nerves terminate in front in the *anterior cutaneous* nerves; the six *upper*, coming through their respective intercostal spaces, supply the skin over the chest; the six *lower* terminate in the front wall of the abdomen, near the linea alba.

FIG. 27.

DIAGRAM OF A SPINAL NERVE.

Notice that the first dorsal nerve ascends nearly perpen-

dicularly over the neck of the first rib to form part of the brachial plexus. Before doing so, it sends a nerve to the first intercostal space. This, as a rule, has no lateral cutaneous branch.

Intercostal lymphatic glands.—These are situated near the heads of the ribs; there are some between the layers of the intercostal muscles. They are of small size, and their efferent vessels go into the thoracic duct. We have seen these intercostal glands enlarged and diseased in phthisis.

Bronchial and Œsophageal Arteries. Small *bronchial arteries*, arising on the right side most frequently from the first aortic intercostal (3rd intercostal) artery, and on the left from the thoracic aorta, accompany the bronchial tube on its posterior aspect into the substance of the lung.* Their distribution and office will be considered with the anatomy of the lung. *Œsophageal arteries* four or five in number proceed from the front of the thoracic aorta to ramify on the œsophagus, where they inosculate above with the œsophageal branches of the inferior thyroid, and below with the coronaria ventriculi and phrenic arteries. Small *posterior mediastinal arteries* are given off from the posterior part of the aorta, and supply the lymphatic glands and tissues of the posterior mediastinum.

Having finished the posterior mediastinum, replace the lung, and turn your attention once more to the great vessels at the root of the heart.

Pulmonary Artery. This vessel is about two inches in length, and conveys the venous blood from the heart to the lungs. It proceeds from the upper part of the right ventricle, and passes upwards and backwards along the left side of the aorta to the concavity of the arch of the aorta, where it divides into two branches, a right and a left, one for each lung. At its origin it has on each side an auricular appendix and a coronary artery, and lies in front of the root of the aorta. The pulmonary artery and the aorta are surrounded for two inches by a common sheath of

* On the left side there are usually two bronchial arteries—a superior, arising from the highest part of the thoracic aorta, and an inferior, arising about an inch lower down.

pericardium. The right branch, the larger and longer, passes below the arch of the aorta to the lung; the left is easily followed to its lung by removing the layer of pericardium investing it.

Search should be made for a short fibrous cord which connects the commencement of the left pulmonary artery with the concavity of the arch of the aorta. This cord is the remains of the *ductus arteriosus*, a canal which in fœtal life conveyed blood from the pulmonary artery to the aorta.

Draw towards the left side the first part of the arch of the aorta, and dissect the pericardium from the great vessels at the base of the heart. Thus a good view will be obtained of the trachea and its bifurcation into the two bronchi. Below the division of the trachea the right pulmonary artery is seen passing in front of the right bronchus. The superior vena cava and aorta are seen in front of, and nearly at right angles to, the right pulmonary artery. The vena azygos is seen arching over the right bronchus and terminating in the vena cava superior. Notice, especially, a number of lymphatic glands called *bronchial*, at the angle of bifurcation of the trachea. The situation of these glands in the midst of so many tubes explains the variety of symptoms which may be produced by their enlargement.

NERVES OF THE HEART AND CARDIAC PLEXUSES. The nerves of the heart come from the pneumogastric and its recurrent branch, and the three cervical ganglia of the sympathetic. The pneumogastric gives off (generally) two or more filaments (cardiac) which proceed from the main trunk in the neck, or from its recurrent branch. The sympathetic sends three (cardiac) filaments; one from the upper cervical ganglion, a second from the middle, and a third from the lower; and they are called, respectively, the upper, middle, and lower cardiac nerves of the sympathetic.

The minute and delicate nerves from these several sources on each side, pass downwards to the base of the heart. They vary very much in their precise relations to the great vessels upon which they run; but speaking generally, it may be said that the nerves on the right side run chiefly behind the arch of the aorta, those on the left, in front of it. Eventually they form, by their mutual

subdivisions and interlacement, an intricate network of nerves, termed, according to their position, the deep and the superficial cardiac plexus.

The *deep* and *larger cardiac plexus* is situated behind the arch of the aorta in front of the bifurcation of the trachea, and immediately above the right pulmonary artery. To see it, the pericardial covering of the aorta must be carefully removed, and the vessel hooked forwards and to the left.

The *superficial* and *smaller cardiac plexus* lies in the concavity of the arch of the aorta in front of the right pulmonary artery. It is closely connected with the deep plexus; and (generally) receives the upper cardiac branch of the left sympathetic, and the lower cardiac branch from the left pneumogastric.

From the cardiac plexuses, as a common centre, the nerves pass off to the heart, forming plexuses around the coronary arteries. Thus, the *anterior coronary plexus* (derived chiefly from the superficial cardiac) accompanies the anterior coronary artery. The *posterior coronary plexus* (derived chiefly from the left side of the deep cardiac) runs with the posterior coronary artery. The two plexuses communicate at the apex of the heart, and in the ventricular septum.

It is not an easy matter to trace the nerves into the substance of the heart. For this purpose a horse's heart is the best, and previous maceration in water is desirable. The nerves in the substance of the heart are peculiar in this respect; that they present minute ganglia in their course, which are presumed to preside over the rhythmical contractions of the heart.

Constituents of the Root of each Lung. Draw aside the margin of the right lung; divide the superior vena cava above the vena azygos, and turn down the lower part. Remove the layer of pericardium which covers the pulmonary veins, and the constituent parts of the root of the right lung will be exposed. It is composed of the pulmonary artery, the pulmonary veins, bronchus, bronchial vessels, anterior and posterior pulmonary plexuses, and some lymphatics. The following is the disposition of the large vessels forming the root of the lung. In front are the

two pulmonary veins: behind the veins are the subdivisions of the pulmonary artery; behind the artery are the divisions of the bronchus. From above downwards they are disposed thus:—On

FIG. 28.

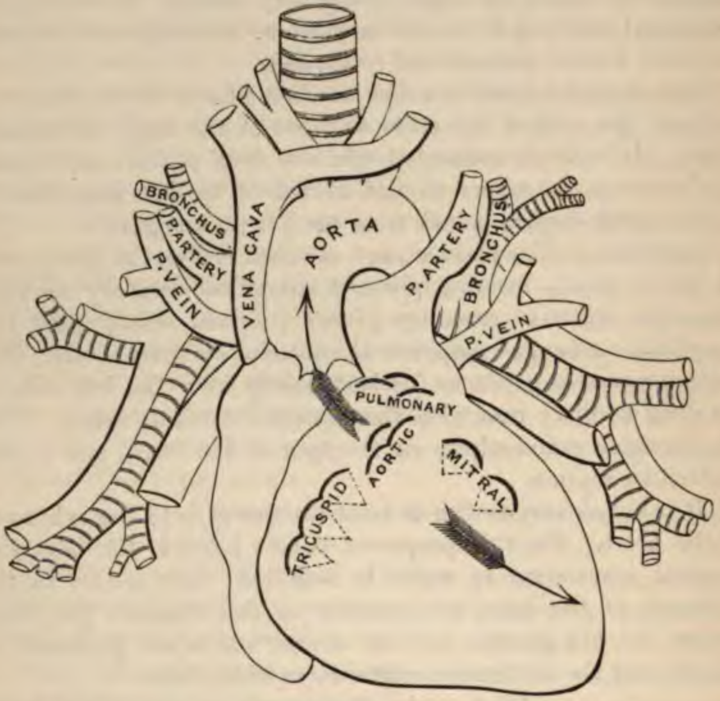


DIAGRAM SHOWING THE CONSTITUENTS OF THE ROOT OF EACH LUNG, AND THEIR RELATIVE POSITION: ALSO THE POSITION OF THE VALVES OF THE HEART. THE ARROWS INDICATE THE DIRECTIONS IN WHICH AORTIC AND MITRAL MURMURS ARE PROPAGATED.

the right side we find—1st, the bronchus; 2nd, the artery; 3rd, the veins. On the left, we find:—1st, the artery; 2nd, the bronchus; 3rd, the veins—as shown in fig. 28.

DISSECTION OF THE HEART.

The heart is conical in form, and more or less convex on its external aspect, with the exception of that portion lying on the tendinous centre of the diaphragm, which is flattened. It is situated obliquely in the thorax, and is completely surrounded by the pericardium. It extends from the fourth to the eighth dorsal vertebra, with its base directed upwards and to the right, its apex downwards and to the left. The position which the heart bears to the thoracic walls has been already described (pp. 134–137); it varies however in different subjects, and as a rule is higher in the dead body than during life, owing to the shrinking of the lungs.

Notice the two longitudinal grooves (*sulci*) on the front and back surfaces of the heart, indicating the septum between the two ventricles; the anterior groove lies nearer to the left side, the posterior, to the right side of the heart.

A circular groove, nearer the base, marks the separation between the auricles and the ventricles. In the circular and longitudinal furrows, surrounded by more or less fat, run the coronary vessels, the nerves and the lymphatics.

SIZE AND WEIGHT. The size of the heart is dependent upon so many conditions, that the following measurements must be received with more or less limitation. An average heart will measure in its transverse direction at the base, three and a half inches; in its length, about five inches; in its thickness, two and a half inches. The weight is from ten to twelve ounces in the male, and from eight to ten in the female, but much depends upon the size and condition of the body generally. As a rule, the heart gradually increases in length, breadth, and thickness from childhood to old age.*

The heart is a double hollow muscular organ; that is, it is composed of two hearts, a right and a left, separated by a septum, and not communicating with each other except during uterine, and rarely in adult, life. Each half consists of two cavities, an auricle and a ventricle, which communicate by a wide orifice,

* Bizot, 'Mém. de la Soc. Méd. d'Observ. de Paris,' tom. i. 1836.

the auriculo-ventricular opening. The right half of the heart propels venous blood to the lungs, and is called the *pulmonary*; the left propels arterial blood from the lungs throughout the body, and is called the *systemic*. These two hearts are not placed apart, because important advantages result from their union. By being enclosed in a single bag they occupy less room in the chest; and the action of their corresponding cavities being precisely synchronous, their fibres, mutually intermixing, contribute to their mutual support.

The cavities of the heart should now be examined in the order in which the blood circulates through them.

RIGHT AURICLE. This is situated at the right side of the base of the heart, and forms a quadrangular cavity, the *atrium* or *sinus venosus*, between the two venæ cavæ, from which it receives the blood. From its front, a small pouch projects towards the left, and overlaps the root of the aorta; this part is termed the '*appendix*' of the auricle, and resembles a dog's ear in shape.

To see the interior, make a horizontal incision through the anterior wall from the apex of the appendix, transversely across the cavity: from this make another upwards at right angles into the superior vena cava. The interior is lined by a polished membrane called the '*endocardium*,' and is everywhere smooth except in the appendix, where the muscular fibres are collected into bundles, called, from their resemblance to the teeth of a comb, '*musculi pectinati*.' They radiate from the auricle to the edge of the auriculo-ventricular opening.

Examine carefully the openings of the two venæ cavæ: they are not directly opposite to each other; the superior is situated on a plane rather in front and a little to the left of the inferior, that the streams of blood may not meet. The inferior cava, after passing through the tendinous centre of the diaphragm, makes a slight curve to the left before it opens into the auricle, that the stream of its blood may be directed towards the auriculo-ventricular opening. The orifice of each vena cava is nearly circular, and surrounded by circular muscular fibres continuous with those of the auricle.

The posterior wall of the auricle is formed by the partition between the auricles, the '*septum auricularum*.' Upon this septum, above and to the left of the orifice of the vena cava inferior, is an oval depression (*fossa ovalis*), bounded by a prominent border (*annulus ovalis*). This depression indicates the remains of the opening (*foramen ovale*) through which the auricles communicated in fœtal life. After birth this opening closes; but if the closure is imperfect, the stream of dark blood in the right auricle mixes with the florid blood in the left, and occasions what is called '*cyanosis*.' A valvular communica-

Fig. 29.

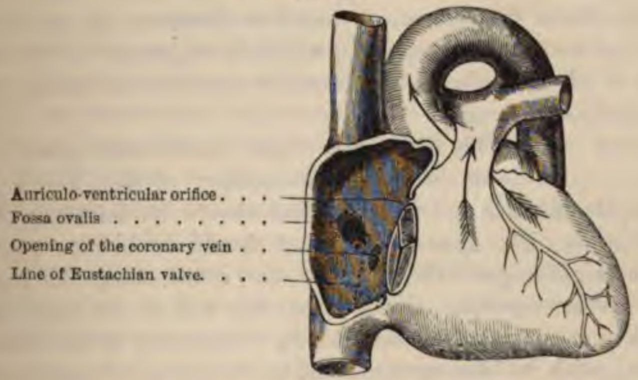


DIAGRAM OF THE INTERIOR OF THE RIGHT AURICLE.

tion, however, not infrequently exists between the auricles in this situation which is not attended with indications of this disease.

A more or less noticeable fold of the lining membrane may be seen projecting from the front margin of the v. c. inferior to the front border of the fossa ovalis. It is the remnant of the '*Eustachian** *valve*,' which was of considerable size in fœtal life, and served to direct the current of blood from the v. c. inferior, through the foramen ovale, into the left auricle.

* Eustachius, 'Libell. de vena sine pari.'

To the left of the Eustachian valve, that is, between its remains and the auriculo-ventricular opening, is the orifice of the *coronary vein*; it is guarded by a semicircular valve, called '*valvula Thebesii*,' to prevent regurgitation of the blood during the auricular contraction. Here and there upon the posterior wall of the auricle may be observed minute openings called '*foramina Thebesii*:' some being the orifices of small veins returning blood from the substance of the heart; others being simple depressions in the muscular tissue. To the left, and rather in front of the orifice of the vena cava inferior, is the *auriculo-ventricular* opening guarded by the tricuspid valve. It is oval in form, and will admit the passage of three fingers. Lastly, between the orifices of the superior and inferior venæ cavæ is a rounded elevation, the *tubercle of Lower* (not seen in the diagram), which is supposed to direct the current of blood in fœtal life, from the superior cava to the auriculo-ventricular opening.

RIGHT VENTRICLE. This forms the right border and about two-thirds of the front surface of the heart. To examine its interior, a triangular flap should be raised from its anterior wall. The apex of this flap should be below: one cut along the right edge of the ventricle, the other along the line of the ventricular septum. Observe that the wall of the ventricle is much thicker than that of the auricle. The cavity of the ventricle is conical, with its base upwards and to the right. From its walls project bands of muscular fibres, '*columnæ carneæ*,' of various length and thickness, which cross each other in every direction; this muscular network is generally filled with coagulated blood. Of these columnæ carneæ there are three kinds: one, stands out in relief from the ventricle; another is attached to the ventricle by its extremities only, the intermediate portion being free; a third, and by far the most important set, called '*musculi papillares*,' is fixed by one extremity to the wall of the ventricle, while the other extremity gives attachment to the fine tendinous cords, '*cordæ tendineæ*,' which regulate the action of the tricuspid valve. The number of these musculi papillares is equal to the number of the chief segments of the valve; consequently there are three in

the right and two in the left ventricle. Of those in the right ventricle, one proceeds from the septum.

There are two openings in the right ventricle. One, the *auriculo-ventricular*, through which the blood passes from the auricle, is oval in form and placed at the base of the ventricle. It is surrounded by a ring of fibrous tissue, to which is attached the tricuspid valve. From the upper and front part of the ventricle, a smooth passage, '*infundibulum*' or '*conus arteriosus*,' leads to the opening of the pulmonary artery. It is situated to the left and in front of the auriculo-ventricular opening, and about three-fourths of an inch higher.

TRICUSPID VALVE. This is situated at the right auriculo-ventricular opening, and consists of three principal triangular flaps, and besides these, of intermediate flaps of smaller size. Like all the valves of the heart, it is formed by a fold of the lining membrane (*endocardium*) of the heart strengthened by fibrous tissue, in which a few muscular fibres may be demonstrated. The bases of the valves are continuous with one another, so that they form a membranous ring between the auricle and ventricle, while the segments project into the cavity of the right ventricle. Of its three principal flaps, the largest or anterior is so placed, that, when not in action, it partially covers the orifice of the pulmonary artery; another, the internal, corresponds with the inferior wall of the ventricle; the third, or posterior, rests upon the septum ventriculorum.

Observe the arrangement of the tendinous cords which regulate the action of the valve. First, they are all attached to the ventricular surface of the valve. Secondly, the tendinous cords proceeding from a given papillary muscle are attached to the adjacent halves of two of the larger flaps, and to a smaller intermediate one; consequently, when the ventricle contracts, and the papillary muscle also, the adjacent borders of the flaps will be approximated. Thirdly, to insure the strength of every part of the valve, the tendinous cords are inserted at three different points of it in straight lines; accordingly, they are divisible into three sets. Those of the first, which are three or four in number, are

attached to the base of the valve; those of the second, from four to six, proceed to the middle of its ventricular surface; those of the third, which are the smallest and most numerous, are attached to its free margin.*

PULMONARY OR SEMILUNAR VALVES.

These are three membranous folds, like watch-pockets, situated at the orifice of the pulmonary artery. They are attached to the fibrous ring at the root of the artery; their free edges look upwards, and present a festooned border, in the centre of which is a small cartilaginous body called the *nodulus* or *corpus Arantii*.† The use of these bodies is plain. Since the valves are semilunar, when they fall together they would not exactly close the artery; there would be a space of a triangular form left between them in the centre, just as there is when we put the thumb, fore, and middle fingers together. This space is filled up by these nodules, so that the closure becomes complete.

The valves are composed of folds of the *endocardium*, or lining membrane of the heart. Between the folds is a thin layer of fibrous tissue, which is prolonged from the fibrous ring at the orifice of the artery. This layer of fibrous tissue, however, reaches the free edge of the valve at three points only: namely, at the centre, or corpus Arantii, and at each extremity. Between these points it stops short, and leaves a crescent-shaped portion of the valve which is thinner than the rest, and consists of the endocardial membrane. This crescent-shaped portion, called the *lunula*, is not wholly

* The best mode of showing the action of the valve is to introduce a glass tube into the pulmonary artery, and then to pour water through it into the ventricle until the cavity is quite distended. By gently squeezing the ventricle in the hand, so as artificially to imitate its natural contraction, the tricuspid valve will flap back like a flood-gate, and close the auriculo-ventricular opening. In this way one can understand how, when the ventricle contracts, the blood catches the margin of the valve, and by its pressure gives it the proper distension and figure requisite to block up the aperture into the auricle. It is obvious that the tendinous cords will prevent the valve from flapping back into the auricle; and this purpose is assisted by the papillary muscles, which nicely adjust the degree of tension of the cords at a time when they would otherwise be too much slackened by the contraction of the ventricle.

† So called after Arantius, an Italian anatomist, who lived towards the close of the sixteenth century.

without fibrous tissue; a thin tendinous cord runs along its free edge, to give it additional strength to resist the pressure of the blood. Behind each of the valves the artery bulges and forms three slight dilatations called the *sinuses of Valsalva.** These, we shall presently see, are more marked at the orifice of the aorta.

The action of these valves is plain. During the contraction of the ventricle the valves lie against the side of the artery, and offer no impediment to the current of blood; during its dilatation, the elasticity of the distended artery would force back the column of blood, but that the valves, being caught by the refluent blood, bag, and fall together so as to close the tube. The greater the pressure, the more accurate is the closure. The coats of the artery are very elastic and yielding, while the valve, like the circumference to which it is attached, is quite unyielding; consequently, when the artery is distended by the impulse of the blood, its wall is removed from the contact of the free margin of the valves, and these are the more readily caught by the regurgitating motion of the blood. The force of the reflux is sustained by the tendinous part of the valves, and by the muscular wall of the ventricle (probably in a state of contraction). The valves are capable of sustaining a weight of sixty-three pounds before they give way.† The thinner portions (*lunulæ*) become placed so as to lie side by side, each one with that of the adjacent valve. This may be demonstrated by filling the artery with water.

LEFT AURICLE. This is situated at the left side and posterior part of the base of the heart, and is somewhat smaller than the right auricle. It is quadrilateral and receives the four pulmonary veins, two on either side, which return the oxygenated blood from the lungs. From its upper and left side, the *auricular appendage* projects towards the right, curling over the root of the pulmonary artery. The auricle should be opened by a horizontal incision from one pulmonary vein to another: from this a second should be made into the appendix. Its interior, the atrium, is smooth and flat, excepting in the appendix, which contains the *musculi pectinati.* Notice the openings of the four

* An Italian anatomist, b. 1666, d. 1723.

† Haller.

pulmonary veins. Upon the septum between the auricles is a semilunar depression indicating the remains of the foramen ovale. At the lower and front part of the auricle is the *auriculo-ventricular opening.* It is oval, with its long axis nearly transverse, and in the adult will admit the passage of two fingers.

LEFT VENTRICLE.

This occupies the left border, and forms the apex of the heart. One third of it only is seen on the anterior surface, the rest being on the posterior. To examine the interior, raise a triangular flap, with the apex below, from its front wall. Observe that its wall is about three times as thick as that of the right ventricle, and that this thickness gradually diminishes towards the apex. The interior of the left ventricle so closely resembles that of the right that there is no necessity to describe it in detail. The *auriculo-ventricular valve* consists of only two principal flaps: hence its name *mitral* or *bicuspid.* The larger of these flaps is placed between the aortic and auriculo-ventricular orifices. There are only two *musculi papillares*; one attached to the anterior, the other to the posterior wall of the ventricle. They are thicker and their *chordæ tendineæ* stronger than those of the right ventricle, but their arrangement is precisely similar. From the upper and back part of the ventricle, a smooth passage leads to the orifice of the aorta. This orifice is placed in the groove between the two auricles, and somewhat in front and to the right side of the left auriculo-ventricular opening. The two orifices are close together, and only separated by the larger flap of the mitral valve. The aortic orifice is guarded by three semilunar valves, of which the arrangement, structure, and mode of action are similar to those of the pulmonary artery. Their framework is proportionately stronger, consistently with the greater strength of the left ventricle, and the greater impulse of the blood. In the *sinuses of Valsalva* are observed the orifices of the two coronary arteries.

SIZE OF THE AURICULO-VENTRICULAR AND ARTERIAL OPENINGS.

The circumferences of the four orifices are as follows: that of the tricuspid orifice, 4·74 inches; that of the mitral 4 inches; that of the pulmonary, 3·55 inches; and that of the aortic, 3·14 inches.*

* Dr. Peacock, 'Croonian Lectures,' 1865.

CORONARY ARTERIES. The heart is supplied with blood by the two coronary arteries, a right or posterior, and a left or anterior. They are about the size of a crow's quill. Both arise from the aorta jüst above the free margins of the two anterior semilunar valves, and thus always allow the passage of blood; both run in the furrows on the surface of the heart; both are accompanied by the cardiac nerves and by lymphatics.

The *anterior* or *left coronary* artery, the smaller of the two, arises from the left side of the aorta. It appears between the pulmonary artery and the appendix of the left auricle, and then divides into two branches: one which seems the continuation of the main trunk and runs down the inter-ventricular furrow on the anterior surface of the heart to the apex; the other passes transversely to the left, in the left auriculo-ventricular groove to the back of the heart.

The *posterior* or *right coronary* artery arises from the right side of the aorta, and descends obliquely between the pulmonary artery and the appendix of the right auricle. It then turns to the right in the groove between the right ventricle and auricle to the back of the heart, where it divides into two branches; one of which descends in the posterior inter-ventricular furrow towards the apex of the heart; the other, which appears to be the continuation of the main trunk, runs in the left auriculo-ventricular groove. Besides these branches, the right coronary gives off a large branch which runs along the free border of the right ventricle.

Thus, the leading trunks of the coronary arteries run in the furrows of the heart, usually surrounded by fat. Their numerous branches supply the walls of the auricles and ventricles, and their terminations communicate slightly with each other.

CORONARY VEINS AND SINUS. The vein which corresponds with the anterior coronary artery ascends in the inter-ventricular sulcus, and then curves round the left side of the heart in the auriculo-ventricular groove, where it takes the name of the *great cardiac vein*. This vein soon dilates into a large trunk, the *coronary sinus*, which opens into the back of the right auricle.

Other veins, known as the *posterior cardiac*, three or four in number, ascend along the posterior surface of the heart, to open by valved orifices into the coronary sinus; while others, the *anterior cardiac veins*, are seen running up on the anterior surface of the right ventricle to terminate directly in the right auricle. The *coronary sinus* is about an inch in length, and its orifice in the right auricle is guarded by a valve (*valve of Thebesius*) to prevent regurgitation of the blood. It is covered and more or less supported in its course by muscular fibres passing from one auricle to the other.

Fig. 30.

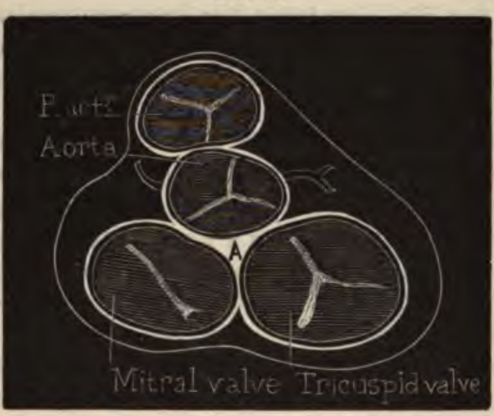


DIAGRAM OF THE RELATIVE POSITION OF THE VALVES OF THE HEART, SEEN FROM ABOVE.

A is placed on the triangular interval where the fibrous skeleton is the thickest.

Fibrous Zones or Skeleton of the Heart. What may be termed the fibrous skeleton of the heart, consists of four rings which surround, respectively, the four orifices at its base: namely, the two auriculo-ventricular, the aortic, and the pulmonary. These rings give attachment by their external circumference to the muscular fibres of the heart, and from their internal circumference send fibrous prolongations to form the framework of the several valves. The skeleton is strongest just in the triangular interspace

between the aortic and the two auriculo-ventricular orifices (letter A in fig. 30). In some animals, as in the ox and the elephant, there is here an irregularly triangular bone, known as the 'os cordis.'

The relative position of these rings is best seen by removing the auricles and the great vessels at the base of the heart—leaving the several valves, and looking at them from above, as shown in the diagram. The pulmonary ring is on the highest level, and nearest to the sternum; below it, is the aortic ring lying between and in front of the auriculo-ventricular rings, which are on the lowest level.

ATTACHMENT OF THE LARGE ARTERIES TO THE VENTRICLES.

The fibrous rings at the arterial orifices present three festoons with their concavities directed upwards. These give attachment, above, to the middle coat of the artery; below, to the muscular fibres of the heart; and, internally, to the fibrous tissue of the valves. The vessels are also connected to the heart by the serous layer of the pericardium, and by a continuation of the lining membrane of the ventricle.

ENDOCARDIUM.

This smooth membrane lining the cavities of the heart resembles the visceral layer of the pericardium, and is continuous with the lining membrane of the blood-vessels. It may be easily stripped off, and is thin and semi-transparent, thicker in the left than in the right cavities, thickest of all in the left auricle. It consists of three layers: 1, a layer of flattened polygonal cells, resting upon, 2, some elastic fibres resembling the fenestrated coat of an artery, and, 3, a thin layer of connective tissue.

ARRANGEMENT OF THE MUSCULAR FIBRES OF THE AURICLES.

The muscular fibres of the heart are of the striped variety, but differ from ordinary striped muscular tissue, in being smaller, destitute of sarcolemma, branched, nucleated, and involuntary. The fibres of the auricles are distinct from those of the ventricles. They consist of a *superficial* layer common to both cavities, and a *deeper* layer proper to each. The *superficial* fibres run transversely across the auricles, and are most marked on the anterior surface; some pass into the septum. Of the *deeper* fibres, some are *annu-*

lar and surround the auricular appendages and the entrance of the great veins, upon which a few may be traced for a short distance; others, *looped*, run over the auricles, and are attached in front and behind to the auriculo-ventricular rings.

ARRANGEMENT OF THE MUSCULAR FIBRES OF THE VENTRICLES.

Speaking generally, it may be said that the right and left ventricles of the heart are two conical muscular sacs, enclosed in a third, which not only envelopes them, but is reflected into the interior of both, at their apices, so as to line their cavities. All the muscular fibres are attached by one end to the fibrous rings of the orifices, and, by the other end, after a more or less spiral course, they reach the rings again, either directly or through the medium of the chordæ tendineæ and valves.

Let us first take the arrangement of the superficial fibres, those, namely, of the sac which envelopes both ventricles. The fibres covering the anterior surface of the heart start from the right auriculo-ventricular and pulmonary rings, and run more or less spirally from right to left towards the apex of the heart: those covering the posterior part of the heart start from the auriculo-ventricular rings, and run more or less spirally from left to right to reach the apex. At the apex what becomes of the fibres? They form a whorl, are reflected upon themselves, and enter the interior of the ventricles so as to form their innermost muscular lining—in other words, the fleshy columns of their cavities.

VENTRICULAR SACS.

Each sac consists of muscular fibres, arranged more or less transversely, which arise from some part of the ring, run round the ventricle, and are fixed to another part of the ring. Thus each sac forms a hollow conical barrel, open at both ends; the broad end representing the orifice of the ring, the narrow end representing the orifice through which the fibres of the common sac enter the ventricles.*

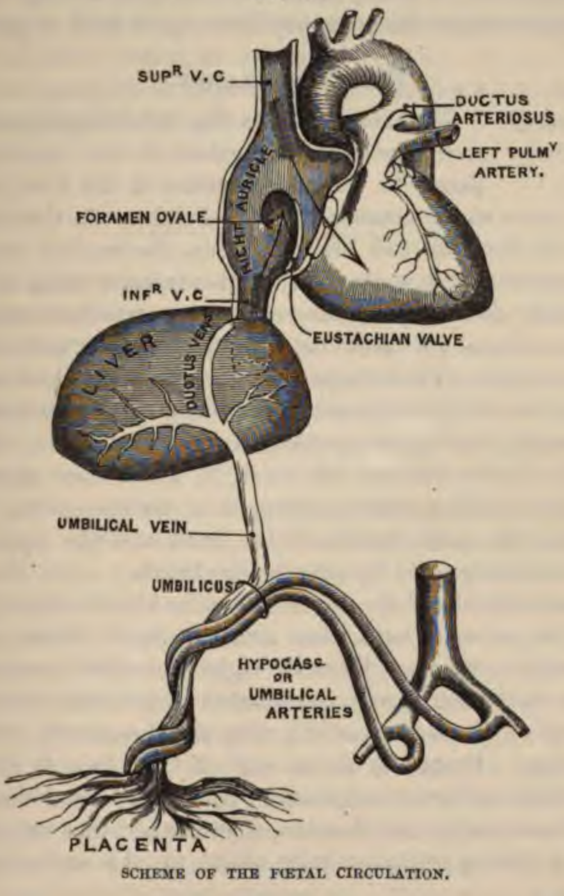
THICKNESS OF THE CAVITIES.

The average thickness of the right auricle is about one line; that of the left, one and a half.

* For further information on this subject, consult Pettigrew, 'Philosoph. Transactions,' 1864; Dr. Sibson, 'Medical Anatomy,' 1869; Winckler, 'Müller's Archiv,' 1865; Quain's 'Anatomy,' vol. ii. p. 257, 1876.

The average thickness of the right ventricle at its thickest part—*i.e.* the base—is about two lines. That of the left ventricle at its thickest part—*i.e.* the middle—is about half an inch. In the female the average is less.

Fig. 31.



SCHEME OF THE FŒTAL CIRCULATION.

Peculiarities of Fœtal Heart. The heart of the fœtus differs from that of the adult in the following points:—1. The *Eustachian valve* is well developed in order to guide the current of blood from

the vena cava inferior into the foramen ovale. 2. The *foramen ovale* is widely open. 3. The *right* and *left pulmonary arteries* are very small and ill developed, so as to admit very little blood to the lungs. 4. The *ductus arteriosus* (from the pulmonary artery to the aorta) is widely open. 5. The *right* and *left ventricles* are of equal thickness because they have equal work to perform.

Fœtal Circulation.

Circulation of the Blood in the Fœtus.

The umbilical vein (fig. 31), bringing pure blood from the placenta, enters at the umbilicus, and passes to the under surface of the liver, where it sends off some small branches to the left lobe. At the transverse fissure it divides into two branches: one, the smaller, termed the *ductus venosus*, passes straight to the inferior vena cava; the other or right division joins the vena portæ, and after ramifying in the liver, returns its blood through the hepatic veins into the inferior vena cava. From the inferior vena cava, the blood enters the right auricle, and this stream (directed by the Eustachian valve) flows through the foramen ovale into the left auricle. From the left auricle it runs into the left ventricle, and thence through the aorta (only a small quantity passing into the descending thoracic aorta) into the great vessels of the head and the upper limbs, which are thus supplied by almost pure blood.

From the head and the upper limbs, the blood returns (impure) through the superior vena cava into the right auricle, and flows into the right ventricle. From the right ventricle it passes through the pulmonary artery, and the *ductus arteriosus*, into the end of the arch of the aorta; only a very small quantity of it going to the lungs. From the aorta, part of the blood is distributed to the pelvis and lower extremities; part is conveyed through the umbilical arteries to the placenta, where it becomes oxygenated.

The following changes take place in the circulation after birth:—

1. The *umbilical vein* becomes obliterated from the second to the fifth day after birth, and subsequently forms the round ligament of the liver.

2. The *ductus venosus* also becomes closed about the same period.

3. The *foramen ovale* and *ductus arteriosus* become completely closed from the sixth to the tenth day.

4. The *pulmonary arteries* enlarge and convey venous blood to the lungs. These organs during fœtal life receive only a small quantity of blood from these arteries.

5. The *hypogastric arteries* become obliterated on the fourth or fifth day after birth.

STRUCTURE OF THE LUNGS.

The lungs are very vascular spongy organs in which the blood is oxygenated by exposure to atmospheric air. Their situation and shape have been briefly described (p. 140). We must now examine the trachea, the common air-passage to both lungs, and then trace this tube downwards to its bifurcation into the two bronchi, which, with their minute subdivisions, form the main structure of the lungs.

TRACHEA. This is a partly membranous, partly cartilaginous tube, and is situated in the middle line. It extends from the cricoid cartilage, *i.e.* opposite the upper border of the sixth cervical vertebra, to the third dorsal vertebra, where it divides into two tubes, the right and left bronchus: one for each lung. Its length is from four to four and a half inches, and its width from eight to ten lines; but these measurements vary according to the age of the patient and the capacity of the lungs. The trachea is surrounded by a quantity of loose connective tissue, so as to allow of its free mobility. It is kept permanently open by a series of incomplete cartilaginous rings, from sixteen to twenty in number, which extend round the anterior two-thirds of its circumference. These rings are deficient at the posterior part of the tube, where it is completed by a fibromuscular membrane. This deficiency allows the trachea to enlarge or diminish its calibre; and for this purpose the membranous part

of the tube is provided with unstriped muscular fibres which can approximate the ends of the rings.

The relations of the trachea to the surrounding parts should be considered, first, in the neck, and then within the thorax.

In the neck, it has in front of it the isthmus of the thyroid body, the sterno-hyoid and sterno-thyroid muscles, the middle thyroid veins, two layers of the deep cervical fascia, the arteria thyroidea ima, if present, and (at the root of the neck) the innominate and left common carotid arteries. Laterally, it is in relation with the lobes of the thyroid body, the common carotid arteries, the recurrent laryngeal nerves, and the inferior thyroid arteries. Behind it, is the œsophagus, inclining slightly to the left.

In the chest, in front of the trachea are the origins of the sterno-hyoid and thyroid muscles, the left brachio-cephalic vein, the first parts of the innominate and left common carotid arteries, the transverse portion of the arch of the aorta, and the deep cardiac plexus. On the right side are the pleura and right pneumogastric nerve; on the left, the pleura, the left carotid, the left pneumogastric, cardiac, and recurrent laryngeal nerves.

BRONCHI, RIGHT AND LEFT. The two *bronchi* differ in length, direction, and diameter. The *right* is shorter than the left, about an inch long, and passes more horizontally to the root of its lung, on a level with the fourth dorsal vertebra. It is larger in all its diameters than the left; hence, foreign bodies which have accidentally dropped into the trachea are more likely to be carried into the right bronchus by the current of the air. The *left* is about two inches in length, and, descending more obliquely to its lung than the right, enters it on a level with the fifth dorsal vertebra.

The vena azygos major arches over the right bronchus, to terminate in the superior v.c. The left bronchus passes under the arch of the aorta in front of the œsophagus, and subsequently crosses in front of the descending aorta.

The *cartilages* of the trachea vary in number from sixteen to twenty, of the right bronchus from six to eight, and of the left from nine to twelve. Those of the trachea form about two-thirds

of a circle, somewhat like a horseshoe in shape, and about one-sixth of an inch in their vertical direction. The first cartilage is the broadest, and that at the bifurcation of the trachea is shaped like the letter V; its angle projects into the centre of the main tube, and its sides belong one to each bronchus.

The cartilages are connected, and covered on their outer and inner surfaces by a tough membrane, consisting of connective and elastic tissues. This membrane is attached above to the circumference of the cricoid cartilage, and is continued through the whole extent of the trachea and bronchial tubes. Posteriorly, where the cartilages are deficient it maintains the integrity of the tube. In this tissue, which is of a pale reddish colour, is a layer of unstriped muscular fibres, arranged in a transverse and a longitudinal direction.

MUSCULAR TISSUE. This thin stratum of unstriped muscular fibres is exposed when the fibrous membrane and tracheal glands have been removed. Some of the fibres extend transversely between the posterior free ends of the cartilages, while some are arranged in longitudinal bundles. By their contraction they approximate the ends of the cartilages, and diminish the calibre of the trachea.

ELASTIC TISSUE. This is chiefly found in the membranous part of the tube, and its fibres run in a longitudinal direction. It is this tissue which raises the mucous membrane into folds, and its elasticity admits of the elongation and the recoil of the tube.

TRACHEAL GLANDS. Between the fibrous and muscular layers of the trachea are a number of small mucous glands, most numerous on the posterior part of the tube. They are compound racemose glands, lined with columnar epithelium, and in health their secretion is clear, and just sufficient to lubricate the air-passages. In bronchitis they are the sources of the abundant viscid expectoration.

MUCOUS MEMBRANE. The *mucous membrane* lining the air-passages is a continuation of that of the larynx. Its colour in the natural state is nearly white, but in catarrhal affections it

becomes bright red, in consequence of the accumulation of blood in the capillary vessels. It is continued into the ultimate air-cells, where it becomes thinner and more transparent. In its deeper layer is found a considerable amount of elastic tissue; in its superficial layer a quantity of lymphoid tissue. Its surface is lined with a layer of columnar ciliated epithelial cells. The vibratile movement of the cilia is directed in such a way as to favour the expectoration of the mucus. The ciliated epithelium lining the mucous membrane ceases at the commencement of the air-cells, where it is replaced by the squamous variety.

At the root of the lung each bronchus divides into two branches, an upper and a lower, corresponding to the lobes of the lung; on the right side, the lower branch sends a small division to the third lobe of the lung. The tubes diverge through the lung, and divide into branches, successively smaller and smaller, until they lead to the air-cells. These ramifications do not communicate with each other; hence, when a bronchial tube is obstructed, all supply of air is cut off from those cells to which it leads.

The several tissues, cartilaginous, fibrous, muscular, mucous, and glandular, which compose the air-passages, are not present in equal proportions throughout all their ramifications, but each is placed in greater or less amount where it is required. The cartilaginous rings necessary to keep the larger tubes permanently open become, in the smaller tubes, fewer and less regular in form. As the subdivisions of the tubes multiply, the cartilages consist of small pieces placed here and there; they become less and less firm, and finally disappear when the tube is reduced to one-fortieth of an inch in diameter. The smallest air-passages are entirely membranous, being formed of fibrous, elastic, and muscular tissues.

THE LUNGS.

The lungs are composed of cartilaginous and membranous tubes, of which the successive subdivisions convey the air into closely-packed minute cells, called the *air-vesicles*; of the ramifications of the pulmonary artery and veins; of the bronchial vessels concerned in their nutrition; of lymphatics and nerves. These component parts are united by

connective tissue, and covered externally by pleura. The part at which they respectively pass in and out is called the *root of the lung*.

The lungs are the lightest organs in the body, and float in water. When entirely deprived of air they sink. This is observed in certain pathological conditions; *e.g.* when one lung is compressed by effusion into the chest, or rendered solid by inflammation.

CONTRACTIBILITY OF THE LUNG.

When an opening is made into the chest, the lung, which was in contact with the ribs, immediately recedes from them, and, provided there be no adhesions, gradually contracts. If the lungs be artificially inflated, either in or out of the chest, we observe that they spontaneously expel a part of the air. This disposition to contract, in the living and the dead lung, is due to the elastic tissue in the bronchial tubes and the air-cells; but more especially to a layer of delicate elastic tissue on the surface of the lung, which has been described by some anatomists as a distinct coat, under the name of the second or inner layer of the pleura.*

COLOUR.

The lungs are of a livid red or violet colour; they often present a mixture of tints, giving them a marble-like appearance. This is not the natural colour of the organ, since it is produced in the act of dying. It depends upon the stagnation of the venous blood, which the right ventricle still propels into the lungs, though respiration is failing. The tint varies in particular situations in proportion to the amount of blood, and is always deepest at the back of the lung. But the colour of the proper tissue of the lung apart from the blood which it contains is pale and light grey. This colour is seldom seen except in the lungs of infants who have never breathed, or after death from profuse hæmorrhage.

Upon or near the surface of the lungs, numerous dark spots are observed, which do not depend upon the blood, since they are seen in the palest lungs. They vary in number and size, and

* In some animals, the seal especially, the elasticity of this tissue is very strongly marked.

increase with age. The source of these discolourations is not exactly known; but they are probably deposits of minute particles of carbonaceous matter which have been inhaled with the air.

WEIGHT. In the male the average weight of the right lung is 24 oz., that of the left, 21 oz.; in the female the average is about 17 oz. on the right, and 15 oz. on the left side.

The total capacity of the lungs in an adult male of ordinary height is 282 cubic inches; and the amount of air still contained in the lungs after a forced expiration has been estimated at 57 cubic inches. The difference between these volumes indicates the amount of air which can be inhaled, from the deepest expiration to the fullest inspiration, and has been termed the *vital capacity* of the lungs.*

LOBULES OF THE LUNG. The surface of the healthy lung is marked by faint white lines, which map it out into a number of angular spaces of various size. These spaces indicate the lobules of the lung. Each lobule is a lung in miniature. Whoever understands the structure of a single lobule, understands the structure of the entire lung. The lobules are connected by fine areolar tissue, called *interlobular*, which is everywhere soft and elastic to allow the free expansion of the organ. The cells of this tissue have no communication with the air-vesicles unless the latter be ruptured by excessive straining, and then this intermediate tissue becomes inflated with air, and is called 'interlobular emphysema.' When infiltrated with serum it constitutes 'œdema' of the lung.

Each lobule receives a small bronchial tube, *lobular bronchial tube*, which subdivides into smaller branches. Thus reduced in size, the walls of the tubes no longer present traces of cartilaginous tissue, but are composed of a delicate elastic membrane upon which the capillaries ramify in a very minute network.† Each tube finally leads into an irregular passage, *lobular passage*, from which proceed on all sides numerous dilatations: these are the

* Hutchinson, 'Med. Chir. Trans.,' vol. xxix. 1846.

† In phthisis the expectoration contains some of the *débris* of this elastic framework of the air-vesicles; it can be seen under the microscope, and is a test of the character of the sputa.

air-cells or *alveoli*, which vary from $\frac{1}{50}$ to $\frac{1}{70}$ of an inch in diameter (fig. 32). The air-cells themselves present a number of shallow depressions, separated by somewhat prominent partitions, so that their interior has a honey-combed appearance, as shown in fig. 32. The purpose of these is to increase the extent of surface upon which the capillaries may ramify. The structure of the minute air-cell of the human lung is in all respects similar to the large respiratory sac of the reptile.

FIG. 32.

ULTIMATE AIR-CELLS OF THE LUNG (FROM KÖLLIKER). MAGNIFIED TWENTY-FIVE TIMES.

The structure of the air-cells differs in some important features from that of the small bronchial tubes; the muscular tissue disappears, the elastic tissue is no longer arranged in bundles, but becomes frayed out and intermingled with the connective tissue, and the ciliated epithelium is replaced by a single layer of squamous epithelium.

PULMONARY VESSELS. The branches of the pulmonary artery subdivide with the bronchial tubes. Their ultimate ramifications spread out in such profusion beneath the epithelium of the air-cells, that a well-injected lung appears a mass of the finest network of capillaries. This network is single and is so close that the interstices are even narrower than the vessels, which are on an average about $\frac{1}{3000}$ of an inch in diameter. The blood and air are not in actual contact. Nothing, however, intervenes but the wall of the cell and the capillary vessels, which are such delicate structures that they oppose no obstacle to the free interchange of gases by which the blood is purified. This purification is effected by the taking in of oxygen, and the elimination of carbonic acid and watery vapour. The most complete purification takes place in the single layer of capillaries between the folds of membrane projecting into the cell; for in this situation both sides of these

vessels are exposed to the action of the air. The blood, circulating in steady streams through this capillary plexus, returns through the pulmonary veins. These, at first extremely minute, gradually coalesce into larger and larger branches which anastomose very freely, and accompany the arteries. They finally emerge from the root of the lung by two large trunks which carry the oxygenated blood to the left auricle of the heart. The pulmonary veins are not provided with valves.

BRONCHIAL ARTERIES. These are small arteries, two or more in number for each lung. The right arises either from the first aortic intercostal, or, conjointly with the left bronchial, from the thoracic aorta. The left comes from the thoracic aorta. They enter the lung behind the divisions of the bronchi, which they accompany. They are the proper nutritive vessels of the organ. The bronchial vessels are distributed in various ways: some of their branches supply the coats of the air-passages, the large blood-vessels and the lymphatic glands; others the interlobular tissue: a few reach the surface of the lung, and ramify beneath the pleura. The right *bronchial veins* terminate in the vena azygos; the left, in the superior intercostal vein.

The *nerves* of the lung are derived from the pneumogastric and the sympathetic. They enter with the bronchial tubes, forming a plexus in front and behind them, *anterior* and *posterior pulmonary plexus*, in which are found minute ganglia.

The *lymphatics* of the lungs commence in the lymphatic capillaries in the interlobular tissue, and thence pass to the surface forming a network which communicates with the subpleural lymphatic plexus: others take their origin in the mucous membrane of the bronchial tubes, and all eventually enter the bronchial glands. Of these, the larger are situated about the bronchi near the root of the lung, particularly under the bifurcation of the trachea.

DISSECTION OF THE PHARYNX.

DISSECTION. To obtain a view of the pharynx, cut through the trachea, the œsophagus and the large vessels of the neck, and then separate them from the bodies of the cervical vertebræ, with which they are loosely connected. The base of the skull should be sawn through transversely between the vertebral column and the styloid processes of the temporal bone, so as to leave the pharynx and the larynx attached to the anterior half of the section. Horsehair should then be introduced through the mouth and œsophagus to distend the walls of the pharynx.

PHARYNX. GENERAL DESCRIPTION. The term pharynx is applied to that part of the alimentary canal which receives the food after it has been masticated, and propels it downwards into the œsophagus. It is a funnel-shaped muscular bag, about four and a half inches in length. Its broadest portion is situated opposite the os hyoides. Its upper part is attached to the basilar process of the occipital bone and the petrous portions of the temporal bones; thence it extends to the lower border of the cricoid cartilage, where the continuation of it takes the name of œsophagus. The bag is connected, in front, to the sides of the posterior nares, the tongue, the hyoid bone and the larynx; and, behind, to the bodies of the cervical vertebræ by loose connective tissue which never contains fat. In abscesses at the back of the pharynx, the pus is seated in this tissue. *Parallel with, and close to its sides, run the internal carotid arteries*, the internal jugular veins, the eighth, ninth and sympathetic nerves. Its dimensions are not equal throughout. Its breadth at the upper part is equal to that of the posterior openings of the nose; here it is only required to convey air: but it becomes much wider in the situation where it transmits the food—that is, at the back of the mouth; thence it gradually contracts to the œsophagus. The pharynx, therefore, may be compared to a funnel communicating in front by wide apertures with the nose, the mouth, and the larynx; while the œsophagus represents the tube leading from its lower end.

The upper part of the funnel forms a cul-de-sac at the basilar process of the occipital bone. At this part there is, on each side, the opening of a narrow canal, called the Eustachian tube, through which air passes to the tympanum of the ear.*

Before the muscles of the pharynx can be examined, we must remove a layer of thin fascia, termed the *pharyngeal fascia.* It is the layer of deep cervical fascia behind the pharynx, and must not be confounded with the proper *pharyngeal aponeurosis,* which intervenes between its muscular and mucous walls.

At the back of the pharynx, near the base of the skull, are a few *lymphatic glands.* They sometimes enlarge, and form a perceptible tumour in the pharynx.

In removing the fascia from the pharyngeal muscles notice that a number of veins ramify and communicate in all directions. They constitute the *pharyngeal venous plexus,* and terminate in the internal jugular veins.

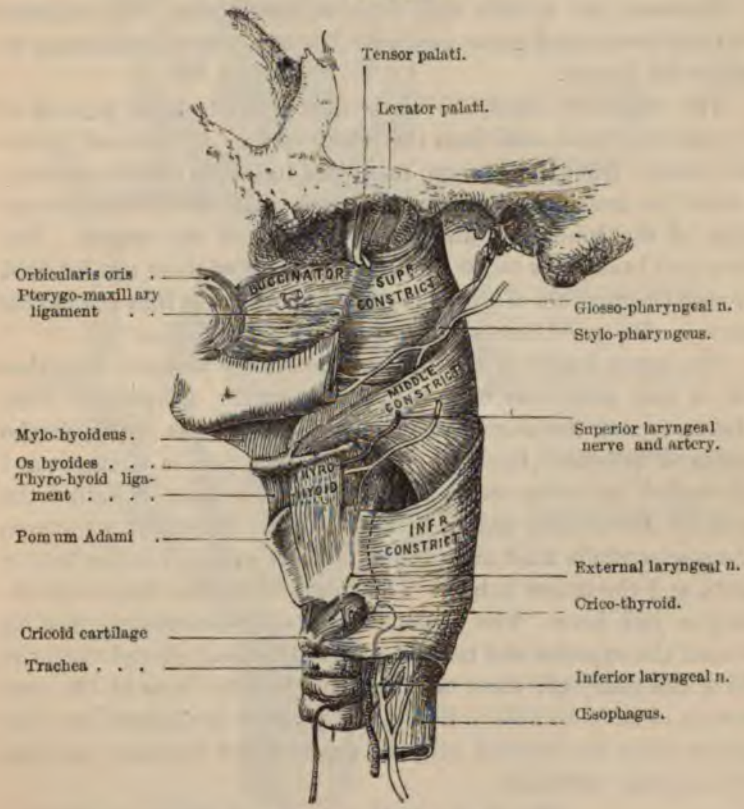
CONSTRICTOR MUSCLES OF THE PHARYNX. They are three in number, and arranged so that they overlap each other—i.e. the inferior overlaps the middle, and the middle the superior (fig. 33). They have the same attachments on both sides of the body; and the fibres from the right and left meet together, and are inserted in the mesial line, the insertion being marked by a white longitudinal line called the *raphé.*

The *inferior constrictor arises* from the side of the cricoid cartilage, from the oblique ridge and the upper and lower borders of the thyroid cartilage. Its fibres expand over the lower part of the pharynx. The superior fibres ascend; the middle run

* Observe that the pharynx conducts to the œsophagus by a gradual contraction of its channel. This transition, however, is in some cases sufficiently abrupt to detain a foreign body, such as a morsel of food more bulky than usual, at the top of the œsophagus. If such a substance become firmly impacted in this situation, one can readily understand that it will not only prevent the descent of food into the stomach, but that it may occasion, by its pressure on the trachea, alarming symptoms of suffocation. Supposing that the obstacle can neither be removed by the forceps, nor pushed into the stomach by the probang, it may then become necessary to extract it by making an incision into the œsophagus on the left side of the neck.

transversely; the inferior descend, and are identified with the œsophagus. Beneath its lower border the recurrent laryngeal nerve enters the larynx. Its nervous supply is from the pharyngeal plexus.

FIG. 33.



MUSCLES OF THE PHARYNX.

The *middle constrictor arises* from the upper edge of the greater cornu of the os hyoides, from its lesser cornu, and part of the stylo-hyoid ligament. Its fibres take different directions, so that, with those of the opposite muscle, they form a lozenge. The

lower angle of the lozenge is covered by the inferior constrictor; the upper angle ascends nearly to the basilar process of the occipital bone, and terminates upon the pharyngeal aponeurosis. The external surface of the muscle is covered at its origin by the hyo-glossus. Its nerve comes from the pharyngeal plexus.

Between the middle and inferior constrictors, the superior laryngeal artery and nerve perforate the thyro-hyoid membrane to supply the larynx.

The *superior constrictor arises* from the hamular process of the sphenoid bone, and from the lower part of its internal pterygoid plate; from the pterygo-maxillary ligament (which connects it with the buccinator); from the back part of the mylo-hyoid ridge of the lower jaw, and from the side of the tongue. The fibres pass backwards to the mesial line: some of them are inserted through the medium of the pharyngeal aponeurosis into the basilar process. Its nerve comes from the pharyngeal plexus.

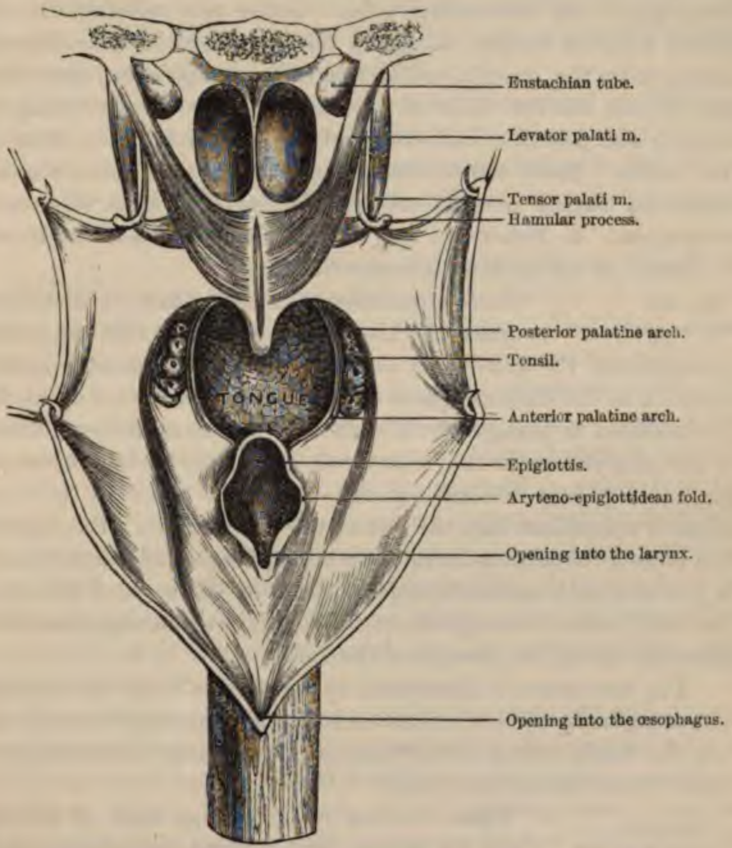
The upper border of the superior constrictor presents, on either side, a free semilunar edge with its concavity upwards, so that, between it and the base of the skull, a space is left in which the muscle is deficient (fig. 33). Here the pharynx is strengthened and walled in by its own aponeurosis. The space is called the *sinus of Morgagni*; and in it, with a little dissection, we expose the muscles which raise and tighten the soft palate: i.e. the levator palati, and the tensor palati. The Eustachian tube opens into the pharynx just here. The fibres of the stylo-pharyngeus pass in between the superior and middle constrictors, and expand upon the side of the pharynx; some of them mingle with those of the constrictors so as to be able to lift up the pharynx in deglutition; but most of them are inserted into the superior and posterior margins of the thyroid cartilage.

PHARYNGEAL MEMBRANE OR APONEUROSIS.

The *pharyngeal aponeurosis* intervenes between the muscles and the mucous membrane of the pharynx. It is attached to the basilar process of the occipital bone, and to the points of the petrous portions of the temporal bones. It maintains the strength and integrity of the pharynx at its upper part, where the muscular fibres are

deficient; but it gradually diminishes in thickness as it descends, and is finally lost on the œsophagus. Notice the number of

Fig. 34.



DIAGRAMMATIC VIEW OF THE PHARYNX LAID OPEN FROM BEHIND.

mucous glands upon this aponeurosis, especially near the base of the skull and the Eustachian tube. These glands sometimes enlarge and occasion deafness from the pressure on the tube.

OPENINGS INTO THE PHARYNX. Lay open the pharynx by a longitudinal incision, and observe the seven openings leading into it (fig. 34):—1. The two posterior openings of the nares. 2. On either side of them, near the lower turbinated bones, are the openings of the Eustachian tubes: below the nares is the soft palate, with the uvula. 3. Below the soft palate is the communication with the mouth, called the isthmus faucium. On either side of this are two folds of mucous membrane, constituting the anterior and posterior half-arches of the palate; between them are the tonsils. Below the isthmus faucium is the epiglottis, which is connected to the base of the tongue by three folds of mucous membrane. 4. Below the epiglottis is the aperture of the larynx. 5. Lastly, is the opening into the œsophagus.*

MUCOUS MEMBRANE. These structures are lined by mucous membrane common to the entire tract of the respiratory passages and the alimentary canal. But this membrane presents varieties in the different parts of these channels, according as they are intended as passages for air or for food. The mucous membrane of the pharynx above the velum palati, being intended to transmit air only, is very delicate in its texture, and lined by columnar ciliated epithelium like the rest of the air-passages. But opposite the fauces, the mucous membrane resembles that of the mouth, and is provided with squamous epithelium. At the back of the larynx the membrane is corrugated into folds, to allow the expansion of the pharynx during the passage of the food.

The membrane is lubricated by a secretion from the numerous mucous glands which are situated in the submucous tissue throughout the whole extent of the pharynx, particularly in the neighbourhood of the Eustachian tubes.

POSTERIOR OPENINGS OF THE NASAL FOSSÆ. These are two oval openings, each of which is about an inch in the long, and half an inch in the short diameter. They are bounded above by the

* On reflecting the mucous membrane at the pharyngeal termination of the Eustachian tube, a thin pale muscle, the *salpingo-pharyngeus*, can be made out. It arises by a thin tendon from the Eustachian tube, and joins the palato-pharyngeus. It is lost among the fibres of the constrictor muscles.

body of the sphenoid bone, externally by its pterygoid plate, below by the horizontal portion of the palate bone; they are separated from each other by the vomer.

On removing the mucous membrane from the posterior part of the roof of the nose and the top of the pharynx, you will find beneath it much fibrous tissue. Hence polypi growing from these parts are, generally, of a fibrous nature.

ISTHMUS FAUCIUM. This name is given to the opening by which the mouth communicates with the pharynx. It is bounded, above by the soft palate and uvula, below by the root of the tongue, and on either side by the arches of the palate, enclosing the tonsils between them.

SOFT PALATE. This movable prolongation of the roof of the mouth is attached to the border of the hard palate, and laterally to the side of the pharynx. Posteriorly it has a free edge, and a pendulous projection in the centre, called the *uvula*. It constitutes an imperfect partition between the mouth and the posterior nares. Its upper or nasal surface is convex and continuous with the floor of the nose; its lower surface is concave, in adaptation to the back of the tongue, and is marked in the middle by a ridge or raphé, indicating its original formation by two lateral halves. The soft palate, when at rest, hangs obliquely downwards and backwards; but in swallowing, it is raised to the horizontal position by the levatores palati, comes into apposition with the back of the pharynx, and thus prevents the food from passing through the nose.

On making a perpendicular section through the soft palate, you see that the great bulk of it is made up of *muciparous glands*, which lie thick on its under surface to lubricate the passage of the food. Above these glands is the palato-glossus, then the aponeurosis of the palate; still higher, are the two portions of the palato-pharyngeus (separated by the fibres of the levator palati), the azygos uvulæ, and, lastly, the nasal mucous membrane. The soft palate is supplied with blood by the descending palatine branch of the internal maxillary, and the ascending palatine branch of the facial. Its nerves are derived from the palatine branches of

the second (superior maxillary) division of the fifth and from the glosso-pharyngeal.

UVULA. The uvula projects from the middle of the soft palate, and gives the free edge of it the appearance of a double arch. It contains a number of muciparous glands, and a small muscle, the *azygos uvulæ*. Its length varies according to the state of its muscle. It occasionally becomes permanently elongated, and causes considerable irritation, a tickle in the throat, and harassing cough. When you have to remove a portion of it, cut off only the redundant mucous membrane.

ARCHES OF THE PALATE. The soft palate is connected with the tongue and pharynx by two folds of mucous membrane on each side, enclosing muscular fibres. These are the *anterior* and *posterior half-arches* or *pillars* of the palate. The *anterior arch* describes a curve from the base of the uvula to the side of the tongue. It is well seen when the tongue is put out. The *posterior arch*, commencing at the side of the uvula, curves along the free margin of the palate, and terminates on the side of the pharynx. The posterior arches, when the tongue is depressed, can be seen through the span of the anterior. The pillars of each side diverge from their origin, and in the triangular space thus formed is situated the tonsil. The chief use of the arches of the palate is to assist in deglutition. The anterior, enclosing the *palato-glossi* muscles, contract so as to prevent the food from coming back into the mouth: the posterior, enclosing the *palato-pharyngei*, contract like side curtains, and co-operate in preventing the food from passing into the nose. In vomiting, food does sometimes escape through the nostrils, but one cannot wonder at this, considering the violence with which it is driven into the pharynx.

MUSCLES OF THE SOFT PALATE. The muscles of the soft palate lie immediately beneath the mucous membrane. There are five pairs—namely, the levatores palati, the circumflexi or tensores palati, the palato-glossi, the palato-pharyngei, and the azygos uvulæ. This last pair is sometimes described as a single muscle.

LEVATOR PALATI. This muscle *arises* from the apex of the petrous portion of the temporal bone and from the under part of the cartilage of the Eustachian tube. Its fibres spread out, and are inserted along the upper surface of the soft palate, meeting those of its fellow in the middle line (fig. 34). Its action is to raise the soft palate, so as to make it horizontal in deglutition. It is supplied by a nerve from the spheno-palatine ganglion.

CIRCUMFLEXUS OR TENSOR PALATI. This muscle is situated between the internal pterygoid m. and the internal pterygoid plate of the sphenoid bone. It *arises* from the scaphoid fossa of the sphenoid bone, and from the outer side of the cartilage of the Eustachian tube. Thence it descends perpendicularly, ends in a tendon which turns round the hamular process, and expands into a broad aponeurosis, which is inserted into the horizontal plate of the palate bone, and is also connected to its fellow of the opposite side. It gives strength to the soft palate. A synovial membrane facilitates the play of the tendon round the hamular process. Its *action* is to draw down and tighten the soft palate, and, owing to its insertion into the palate bone, also to keep the Eustachian tube open. Its nerve is derived from the otic ganglion, and enters the muscle on its inner aspect.

AZYGOS OR LEVATOR UVULÆ. This consists of two thin bundles of muscular fibres situated one on each side of the middle line. It arises from the aponeurosis of the palate and descends along the uvula nearly down to its extremity. It receives its nerve from the spheno-palatine ganglion.

PALATO-GLOSSUS AND PALATO-PHARYNGEUS. These muscles are contained within the arches of the soft palate. The *palato-glossus*, within the anterior arch, proceeds from the anterior surface of the soft palate to the side of the tongue, and is lost in the stylo-glossus muscle. The *palato-pharyngeus*, within the posterior arch, arises from the posterior border of the soft palate by two origins separated by the levator palati. As it descends its fibres spread out and, passing along the side of the pharynx, blend with the fibres of the inferior constrictor and the stylo-pharyngeus.

Both these muscles are supplied by the descending palatine branches of the spheno-palatine ganglion.

TONSILS. The tonsils are situated at the entrance of the fauces, between the arches of the soft palate. Their use is to lubricate the fauces during the passage of the food. On their inner surface are visible from twelve to fifteen orifices leading into crypts which make the tonsil appear like the shell of an almond. Hence, as well as from their oval figure, they are called the *amygdalæ*.

These openings lead into small follicles in the substance of the tonsil, lined by mucous membrane. Their walls are thick, and formed by a layer of closed cells situated in the submucous tissue. The fluid secreted by these cells is viscid and transparent, in the healthy state: but it is apt to become white and opaque in inflammatory affections of the tonsils, and occasionally accumulates in these superficial depressions, giving rise to the deceptive appearance of a small ulcer, or even a slough in the part.

The tonsil lies close to the inner side of the internal carotid artery. It is only separated from this vessel by the superior constrictor and the aponeurosis of the pharynx. Therefore, in removing a portion of the tonsil, or in opening an abscess near it, the point of the instrument should never be directed outwards, but *inwards* towards the mesial line.* The tonsil is supplied with blood by the tonsillar and palatine branches of the facial, and by the descending palatine branch of the internal maxillary. Nerves are furnished to it from the glosso-pharyngeal.

EUSTACHIAN TUBE. This canal conveys air from the pharynx to the tympanum of the ear. Its orifice is situated opposite the back part of the inferior spongy bone. The direction of the tube from the pharynx is upwards, backwards, and outwards; it is an inch and a half long. The narrowest part is about the middle, and here its walls are in contact. Near the tympanum its walls are osseous, but towards the pharynx they are

* Cases are related by Portal and Béclard, in which the carotid artery was punctured in opening an abscess in the tonsil. The result was immediately fatal hæmorrhage.

composed of fibro-cartilage and fibrous membrane. The cartilaginous end projects between the origins of the levator and the tensor palati, and gives attachment to some of their fibres. It is situated at the base of the skull, in the furrow between the petrous portion of the temporal and the great wing of the sphenoid bone. It adheres closely to the bony furrow, as well as to the fibro-cartilage filling up the foramen lacerum medium. The orifice is not trumpet-shaped, as usually described, but an elliptical slit about half an inch long and nearly perpendicular. The fibro-cartilage bounds it only on the inner and the upper part of the circumference; the integrity of the canal below is maintained by tough fibrous membrane.

The Eustachian tube is lined by a continuation of the mucous membrane of the pharynx, and covered by ciliated epithelium. That which lines the cartilaginous portion of the tube is thick and vascular, and gradually becomes thinner towards the tympanum. Hence, inflammatory affections of the throat or tonsils are liable to be attended with deafness, from temporary obstruction of the tube.

Mucous glands surround the orifice of the tube, and are similar in nature and function to the glands beneath the mucous membrane of the mouth, the palate, and the pharynx.

HARD PALATE.

The hard palate, formed by the superior maxillary and palate bones, is a resisting surface for the tongue in tasting, in mastication, in deglutition, and in the articulation of sounds. The tissue covering the bones is thick and close in texture, and firmly united to the asperities on the bones. But it is not everywhere of equal thickness. Along the raphé in the mesial line, it is much thinner than at the sides; for this reason, the hard palate is in this situation more prone to be perforated in syphilitic disease.

A thick layer of glands (*glandulæ palatinæ*) is arranged in rows on either side of the hard palate. These glands become more numerous and larger towards the soft palate. Their orifices are visible to the naked eye. The mucous membrane has a very thick epithelial coat, which gives the white colour to the palate.

The descending palatine branch of the internal maxillary artery, and the palatine nerves from the superior maxillary, may be traced along each side of the roof of the mouth. The ramifications of these arteries and nerves supply the soft as well as the hard palate.

MECHANISM OF DEGLUTITION. With the anatomy of the parts fresh in your mind, consider for a moment the mechanism of deglutition. The food duly masticated, is collected into a mass upon the back of the tongue; the lower jaw is then closed to give a fixed point for the action of the muscles which raise the os hyoides and larynx, and the food is carried back into the pharynx by the pressure of the tongue against the palate, at the same time that the pharynx is elevated and expanded to receive it (by the stylo-pharyngei on each side).* The food, having reached the pharynx, is prevented from ascending into the nasal passages by the approximation of the posterior palatine arches, and the elevation of the soft palate, which thus forms a horizontal temporary roof to the pharynx; it is prevented from returning into the mouth by the pressure of the retracted tongue, and the contraction of the anterior palatine arches: it cannot enter the larynx, because its upper opening is closed and protected by the falling of the epiglottis: † consequently, being forcibly compressed by the constrictors of the pharynx, the food passes into the œsophagus, through which it is conveyed into the stomach by the undulatory contraction of that tube.

The food passes with different degrees of rapidity through the different parts of its course; but most rapidly through the pharynx. The necessity of this is obvious, as the air-tube must be closed while the food passes over it, and the closure produces a temporary interruption to respiration. The progress of the food through the œsophagus is slow and gradual.

* The larynx being also elevated and drawn forward, a greater space is thus left between it and the vertebræ for the distension of the pharynx.

† This falling of the epiglottis is effected, not by special muscular agency, but by the simultaneous elevation of the larynx and the retraction of the tongue. A perpendicular section through all the parts concerned is necessary to show the working of this mechanism.

DISSECTION OF THE LARYNX.

SITUATION AND RELATIONS. The larynx is the upper part of the air-passage, in which vocalisation takes place. It is a complicated apparatus consisting of numerous cartilages articulated together to form an open tube.

It forms a prominence in the middle line of the neck, covered in front by the integument and cervical fascia, the sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles and the thyroid body. It has the great vessels of the neck on each side. Above, it is attached to the hyoid bone; below, it is continuous with the trachea; behind it, is the pharynx, into which it opens.

Before commencing the dissection of the larynx, the student should make himself acquainted with the cartilages which compose it, and the ligaments which connect them, as seen in a dry preparation.

OS HYOIDES. This bone, named from its resemblance to the Greek Upsilon, is situated between the larynx and the tongue, and serves for the attachment of the muscles of the tongue. It may be felt immediately below, and one inch and a half behind, the symphysis of the jaw. It consists of a body, two greater and two lesser cornua. The *body* is the thick central portion. Its anterior surface is convex, and has a median vertical ridge; on each side of which are depressions for the attachments of muscles; its posterior surface is smooth, concave, and corresponds to the epiglottis. The *greater cornua* (right and left) project backwards for about an inch and a half, with a slight inclination upwards, and terminate in blunt ends tipped with cartilage. In young subjects they are connected to the body of the bone by fibro-cartilage; this in process of years becomes ossified. The *lesser cornua* are connected, one on each side, to the point of junction between the body and the greater cornua, by means of a little joint lined with synovial membrane, which admits of free motion. They are of the size of a barley-corn, and give attachment to the stylo-hyoid ligaments.

LIGAMENTS.

The os hyoides is connected with the thyroid cartilage by several ligaments, which contain a quantity of elastic tissue. There is :—1. The *thyro-hyoid membrane*, which proceeds from the superior border of the thyroid cartilage to the upper and posterior part of the hyoid bone. In front of this membrane there is a bursa, of which the use is to facilitate the play of the thyroid cartilage behind the os hyoides. The central portion is stronger than the lateral, and is called the *anterior thyro-hyoid ligament.* Through the lateral part of this membrane, the superior laryngeal nerve and artery enter the larynx. 2. The right and left *lateral thyro-hyoid ligaments* extend between the extremities of the greater cornua of the os hyoides, and the ascending cornua of the thyroid cartilage. They often contain a small nodule of cartilage, *cartilago triticea.*

CARTILAGES OF THE LARYNX.

The framework of the larynx is composed of nine cartilages—viz., the thyroid, the cricoid, the two arytenoid, the two cornicula laryngis, the two cuneiform cartilages and the epiglottis. These are connected by joints and elastic ligaments, so that they can be moved upon each other by their respective muscles; the object of this motion being to act upon two elastic ligaments called the *vocal cords*, upon the vibration of which phonation depends.

THYROID CARTILAGE.

This cartilage, so called because it shields the mechanism behind it,* consists of two lateral halves, *alæ*, united at an acute angle in front, which forms the prominence termed the *pomum Adami.* This prominence presents a notch at its upper part, to allow it to play behind the os hyoides in deglutition. There is a bursa in front of it. Each ala is somewhat quadrilateral in form, and presents for examination two surfaces and four borders. The *outer* surface of each ala is marked by an oblique line passing downwards and forwards from the upper cornu, which gives attachment to the sterno-thyroid and thyro-hyoid muscles. The smooth surface behind the ridge, gives attachment to the inferior constrictor. The *inferior* border is slightly arched in the middle, and on either side presents a convex

* Θυρεὸς, a shield.

prominence, which gives attachment to the crico-thyroid muscle. The *superior* border is nearly horizontal. The *posterior* border is nearly vertical, and gives insertion to the stylo-pharyngeus and palato-pharyngeus muscles. This border terminates above and below in round projections called the *upper* and *lower cornua.* The upper is the longer; the lower articulates with the side of the cricoid cartilage.

CRICOID CARTILAGE. This cartilage, named from its resemblance to a ring,* is situated below the thyroid. It is not of equal depth all round. It is narrow in front, where it may be felt about one quarter of an inch below the thyroid; from this part, the upper border gradually rises, so that posteriorly, the ring is an inch in vertical depth, and occupies part of the interval left between the alæ of the thyroid. In the middle of this broad posterior surface is a vertical ridge, on either side of which observe a superficial excavation for the origin of the crico-arytenoidei postici: to the lower part of the vertical ridge are attached some of the longitudinal fibres of the œsophagus. On its *upper* part are two oval slightly convex surfaces for the articulation of the arytenoid cartilages. In front, its upper border presents a broad excavation to which the crico-thyroid ligament is attached. On its *outer* surface, external to the depression for the crico-arytenoideus posticus, is an elevated facet which articulates with the inferior cornu of the thyroid cartilage. In front of this articular surface it gives attachment to the inferior constrictor of the pharynx. The *lower* border is connected by elastic membrane to the first ring of the trachea. The *inner* surface is smooth, and the upper border is elliptical; its lower being nearly circular.

LIGAMENTS. The thyroid cartilage is connected to the cricoid by a membrane—the *crico-thyroid.* It consists of a median triangular portion composed mainly of elastic tissue, with its base directed upwards. The lateral portions are thin and membranous, extending as far backwards as the articular facets for the thyroid cartilage, and are intimately connected with the inferior vocal cords. Between the inferior cornu of the thyroid

* Κρίκος, a ring.

cartilage and the cricoid there is a distinct joint, having a synovial membrane, and strengthened by a capsular ligament. The articulation allows of a movement revolving upon its own axis, and, consequently, permits the approximation of the two cartilages.

ARYTENOID CARTILAGES. These cartilages are situated, one on each side, at the back of the cricoid cartilage. In the recent state, before the membranes and muscles have been removed, the space between them resembles the lip of a ewer*; hence their name. Each is pyramidal, with the apex upwards, and is about five or six lines in height, and three lines in diameter at its base. The *posterior* surface of each is triangular and concave, and gives attachment to the arytenoideus muscle: the *anterior* surface is irregular and convex, affording attachment to the thyro-arytenoideus, and to the superior or false vocal cord: the *internal* surface, the narrowest and nearly flat, faces the corresponding surface of the opposite cartilage, and is covered with mucous membrane. The *base* is broad, and presents a smooth somewhat triangular surface which articulates with the cricoid cartilage: in front of the base is the pointed *anterior angle*, which gives attachment to the true vocal cord, and contributes to form part of the boundary of the rima glottidis: at the outer and back part of the base is the *external angle*, into which certain muscles moving the cartilage are inserted: viz. the crico-arytenoideus posticus and crico-arytenoideus lateralis. The base is articulated with the cricoid by a joint which has a loose capsular ligament and a synovial membrane, permitting motion in all directions, like the first joint of the thumb. The *apex* is truncated and points backwards and inwards. It is surmounted by a cartilaginous nodule, called the *corniculum laryngis*.

CUNEIFORM CARTILAGES. These cartilages, sometimes called the cartilages of Wrisberg, are conical in form, and somewhat curved, with their broader part directed upwards and forwards. They are contained in the aryteno-epiglottidean fold.

EPIGLOTTIS. This piece of yellow fibro-cartilage is situated in the middle line, and projects over the larynx like

* Αρύταινα, a ewer.

a valve. It is like a leaf with its stalk directed downwards. Its ordinary position is perpendicular, leaving the upper opening of the larynx free for respiration; but during the elevation of the larynx in deglutition it becomes horizontal, falls downwards and backwards over the larynx, and prevents the entrance of food into it. This descent of the epiglottis is accomplished, not by special muscular agency, but by the simultaneous elevation of the larynx and the retraction of the tongue. Its apex or lower part is attached by the *thyro-epiglottic ligament* to the angle of the thyroid cartilage; it is also connected by an elastic ligament, *hyo-epiglottic*, to the os hyoides. Laterally its borders are rather turned backwards, and to them are attached two folds of mucous membrane which pass to the arytenoid cartilages, called the *aryteno-epiglottic folds.* Its anterior surface is only free at its base, where it is connected with the base of the tongue by the three *glosso-epiglottic folds.* Its posterior or laryngeal surface is concavo-convex and free, and looks towards the larynx. The surface of the epiglottis is closely invested by mucous membrane; this being removed, the yellow cartilage of the epiglottis is seen pitted and often perforated by the small muciparous glands.

The cartilages of the larynx resemble those of the ribs in structure. In the young they are dense and elastic, but some have a tendency to ossify with age. In very old subjects, the thyroid and cricoid cartilages are often completely ossified, and their interior presents an areolar tissue, containing oily matter, analogous to the spongy texture of the bones. The epiglottis, cornicula laryngis and cuneiform cartilages are rarely ossified, on account of their composition, which resembles that of the ear and the nose.

The larynx must now be examined in its perfect condition.

MUCOUS MEMBRANE OF THE LARYNX.

Except on the true vocal cords and the epiglottis, the mucous membrane of the larynx presents a wrinkled appearance, and is loosely connected to the subjacent structures by an abundance of fibro-cellular tissue, which admits of its being elevated into large folds. This tissue deserves notice from the rapidity with which it becomes the seat of serous effusion in acute inflammation of the larynx, and thus produces

symptoms of suffocation. From the root of the tongue to the anterior surface of the epiglottis, the membrane forms three folds, *glosso-epiglottic*, one median, and two lateral, containing elastic tissue. From the epiglottis, to which it is intimately adherent, it is continued backwards on either side to the apices of the arytenoid cartilages, forming the *aryteno-epiglottic folds* which bound the entrance into the larynx. In the natural state it is of a pale rose colour, and covered by ciliated epithelium below the false vocal cords, above these by squamous epithelium.

The mucous membrane of the larynx is remarkable for its acute sensibility. This is requisite to guard the upper opening of the larynx during the passage of the food over it. The larynx is closed during the act of deglutition; but if, during this process, anyone attempt to speak or laugh, the epiglottis is raised, and allows the food to pass, as it is termed, the wrong way. As soon as the foreign body touches the mucous membrane of the larynx, a spasmodic fit of coughing expels it.

The sub-mucous tissue of the larynx is studded with mucous glands. An oblong mass of them lies in the aryteno-epiglottic fold, and they are particularly numerous about the ventricles of the larynx. The surface of the epiglottis towards the tongue is abundantly provided with them. Their ducts pass through the epiglottis, and may be recognised as minute openings on its laryngeal aspect.

SUPERIOR OPENING OF THE LARYNX. This is the opening through which the larynx communicates with the pharynx. Its outline is triangular, with its base directed forwards, and it slopes from before backwards. Anteriorly it is bounded by the epiglottis, laterally by the aryteno-epiglottic folds and cuneiform cartilages, posteriorly by the arytenoid cartilages and the cornicula laryngis. The apex presents the funnel-shape appearance from which the arytenoid cartilages derive their name.

INFERIOR OPENING OF THE LARYNX, OR RIMA GLOTTIDIS. Look down into the larynx and observe the triangular horizontal opening in the middle line; this is the *rima glottidis* or *glottis*. Its apex is directed forwards, its base backwards. The anterior two-thirds of this opening is bounded by the inferior or true

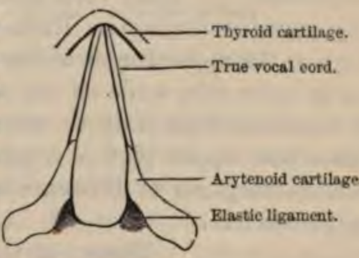
vocal cords, the posterior third by the arytenoid cartilages. Above the true vocal cords are situated the *superior* or *false vocal cords*. On each side of the larynx, between the *true* and *false vocal cords*, is a small recess, *the ventricle of the larynx*, leading into a pouch called the *sacculus laryngis*, which ascends for a short distance and terminates in a cul-de-sac by the side of the thyroid cartilage.

In the middle line below the base of the epiglottis is seen a round elevation covered with mucous membrane of a bright red colour: this is termed the *cushion* of the epiglottis. The length of the rima glottidis in the male is eleven lines; its width at rest from three to four lines; in the female its length is eight lines, its width two lines.

Superior or False Vocal Cords. These are the prominent crescentic folds which form the upper boundaries of the ventricles. They are called the *false vocal cords* because they have little or nothing to do with the production of the voice. They are composed of elastic tissue, like the true vocal cords; but they also contain fatty tissue, which the true ones do not.

Inferior or True Vocal Cords. These two cords, composed of elastic tissue, and covered with very thin and closely adherent mucous membrane, extend horizontally from the angle of the thyroid cartilage to the base of each of the arytenoid. They diverge as they pass backwards; the space between them is called the *rima glottidis*. We shall presently see that, by the muscles which act upon the arytenoid cartilages, these cords can be approximated or separated from each other; in other words, the rima glottidis can be closed or dilated. When sufficiently tightened, and brought parallel by means of certain muscles, the cords are made to vibrate by the current of the expired air, and thus is produced the voice.

Fig. 35.



SHAPE OF THE GLOTTIS WHEN AT REST.

In the adult male the true vocal cords measure about seven lines; in the female about five lines. In boys they are shorter; hence their peculiar voice. At puberty, the cords lengthen, and the voice breaks. The free edges of the true vocal cords are thin and sharp, and look somewhat upwards; this may be demonstrated by making a vertical transverse section through them.

The glottis admits of being dilated, contracted, and even completely closed by its appropriate muscles. When at rest, its shape is triangular, as shown in fig. 35, where the arytenoid cartilages are cut through on a level with the vocal cords. During every inspiration, the glottis is dilated by the crico-arytenoidei postici; it then becomes spear-shaped (fig. 37). During expiration, it resumes its triangular shape: and this return to a state of rest is effected, not by muscular agency, but by two elastic ligaments shown in fig. 35, which draw the arytenoid cartilages together. Thus then the glottis, like the chest, is dilated by *muscular* tissue; like the chest, also, it is contracted by *elastic* tissue. In speaking or singing, the glottis assumes what is called the vocalising position — that is, the opening becomes narrower and its edges nearly parallel.

VENTRICLES OF THE LARYNX. These are the hollows between the upper and lower vocal cords, and each leads to a small pouch, the *sacculus laryngis*. Each ascends for about half an inch as high as the upper border of the thyroid cartilage, which bounds it on its outer side, while on the inner side is the upper vocal cord. It contains from sixty to seventy muciparous glands. Over its inner and upper part is a layer of muscular tissue, *compressor sacculi laryngis* of Hilton, which connects it with the aryteno-epiglottic fold.

INTRINSIC MUSCLES OF THE LARYNX. There are eleven muscles which act upon the larynx: five on each side and one in the middle. The five pairs are—the crico-thyroidei, the crico-arytenoidei postici, the crico-arytenoidei laterales, the thyro-arytenoidei, and the aryteno-epiglottidei. The single one is the arytenoideus.

M. Crico-thyroideus. This muscle is situated on the front of the larynx. It *arises* from the side of the cricoid cartilage, ascends obliquely outwards, and is *inserted* into the inferior border and lower cornu of the thyroid. Its *action* is to tigthen the vocal cords. It does this by depressing the thyroid cartilage: since this cartilage cannot be depressed without lengthening these cords, as shown by the dotted line, fig. 36. Its nerve is the *external laryngeal* branch of the superior laryngeal. Between the anterior borders of the two muscles is seen the crico-thyroid membrane, which is divided in Laryngotomy.

Fig. 36.

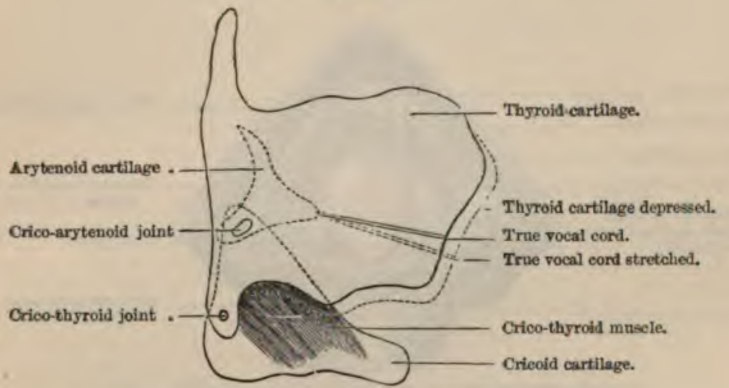


DIAGRAM SHOWING THE ACTION OF THE CRICO-THYROID MUSCLE.

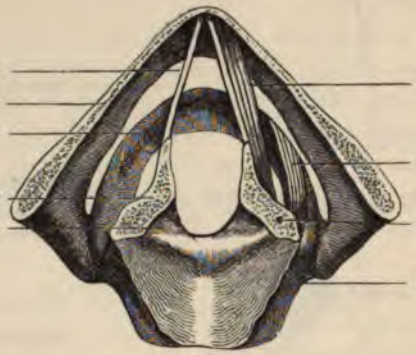
M. Crico-arytenoideus Posticus. This muscle *arises* from the posterior part of the cricoid cartilage: its fibres converge and pass outwards and upwards, to be *inserted* into the outer angle of the arytenoid. Its *action* is to dilate the glottis. It does this by drawing the posterior tubercle of the arytenoid cartilage *towards* the mesial line, and therefore the anterior angle (to which the vocal cord is attached) *from* the mesial line (fig. 37). In this movement the arytenoid cartilage rotates as upon a pivot, and acts as a lever of the first order; the fulcrum or ideal pivot being intermediate between the power

and the weight. This muscle dilates the glottis at each inspiration. Its nerve comes from the inferior laryngeal.

M. ARYTENOIDEUS. This single muscle is situated immediately at the back of the arytenoid cartilages. The fibres pass across from one cartilage to the other running in a transverse direction. *Action.*—By approximating the arytenoid cartilages, they assist in contracting the glottis. It is supplied by the inferior laryngeal nerve.

M. ARYTENO-EPIGLOTTIDEUS. This muscle *arises* from the outer angle of the arytenoid cartilage and, crossing its fellow like

FIG. 37.



GLOTTIS DILATED. MUSCLES DILATING IT REPRESENTED WAVY.

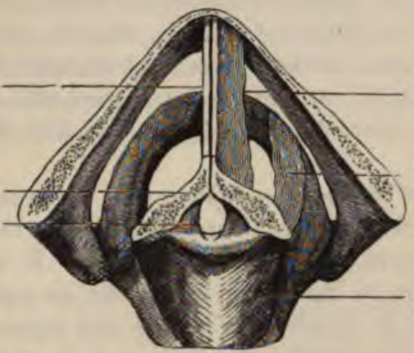
the letter X, is *inserted*, partly into the apex of the opposite arytenoid cartilage, and partly into the aryteno-epiglottidean fold.

M. CRICO-ARYTENOIDEUS LATERALIS. To expose this muscle, cut away the ala of the thyroid cartilage. It *arises* from the upper border of the side of the cricoid cartilage, and is *inserted* into the external angle of the base of the arytenoid in front of the crico-arytenoideus posticus. *Action.*—By drawing the arytenoid cartilages inwards, the muscles of opposite sides contract the glottis (fig. 38). Its nerve comes from the inferior laryngeal.

M. THYRO-ARYTENOIDEUS. This muscle *arises* from the angle of the thyroid cartilage and the crico-thyroid membrane, runs horizontally backwards, and is *inserted* into the base and anterior border of the arytenoid. Its fibres run parallel with the vocal cord, and some of them are directly inserted into it. Its nerve comes from the inferior laryngeal.

This muscle relaxes the vocal cord. More than this, it puts the lip of the glottis in the vocalising position ; in this position, the margins of the glottis are parallel, and the chink is reduced to the breadth of a shilling.

FIG. 38.



GLOTTIS CLOSED. MUSCLES CLOSING IT REPRESENTED WAVY.

The following table shows the action of the several muscles which act upon the glottis :—

Crico-thyroidei . . .	Stretch the vocal cords.	
Thyro-arytenoidei . .	Relax the vocal cords, and place them in the vocalising position.	
Crico-arytenoidei postici .	Dilate the glottis.	
Crico-arytenoidei laterales .	Draw together the arytenoid cartilages	close the glottis.
Arytenoideus . . .	Ditto ditto ditto	
Aryteno-epiglottidei . .	Contract the upper opening of the larynx.	

The *blood-vessels of the larynx* are derived from the *superior*

and *inferior thyroid arteries.* The laryngeal branch of the superior thyroid passes through the thyro-hyoid membrane with the corresponding nerve, and divides into branches, which supply the muscles and the mucous membrane. The laryngeal branches of the inferior thyroid ascend behind the cricoid cartilage. A constant little artery passes through the crico-thyroid membrane.

The *nerves* of the larynx are the *superior* and *inferior* (*recurrent*) *laryngeal* branches of the pneumogastric.

The *superior laryngeal*, having passed through the thyro-hyoid membrane, divides into branches, distributed to the mucous membrane of the larynx. Its filaments spread out in various directions; some to the anterior and posterior surfaces of the epiglottis, and to the aryteno-epiglottidean folds, others to the interior of the larynx and the vocal cords. A constant filament descends behind the ala of the thyroid cartilage, and communicates with the inferior laryngeal. Its external laryngeal branch supplies the crico-thyroid muscle.

The *inferior* (or *recurrent*) *laryngeal nerve* enters the larynx beneath the inferior constrictor, and ascends behind the joint between the thyroid and cricoid cartilages. It supplies all the intrinsic muscles of the larynx, except the crico-thyroid. If the recurrent nerve be divided, or in any way injured, the muscles moving the glottis become paralysed, but its sensibility remains unimpaired. When the nerve is compressed by a tumour—for instance, an aneurysm of the arch of the aorta—the voice is changed to a whisper,* or even lost.

DIFFERENCE BETWEEN THE MALE AND THE FEMALE LARYNX.

Until the approach of puberty, there is no great difference in the relative size of the male and female larynx. The larynx of the male, within two years after this time, becomes nearly doubled in size; that of the female grows, but to a less extent.

The larynx of the adult male is in all proportions about one third larger than that of the adult female.

The alæ of the thyroid cartilage form a more acute angle in

* 'Medical Gazette,' Dec. 1843.

the male; hence the greater projection of the 'pomum Adami,' and the greater length of the vocal cords, in the male.

The average length of the vocal cords is in the	Male .	. 7 lines.
	Female	. 5 lines.
The average length of the glottis is in the .	Male .	. 11 lines.
	Female	. 8 lines.

The size of the larynx does not necessarily follow the proportions of the general stature; it may be as large in a little person as in a tall one: this corresponds with what we know of the voice.

CRICO-THYROID ARTICULATION. This joint is provided with a capsule and synovial membrane. There are, besides, two strong ligaments. Both proceed from the cornu of the thyroid cartilage; the one upwards and backwards, the other downwards and forwards to the cricoid. Remember that the only kind of motion permitted is vertical: and that this motion regulates the tension of the vocal cords.

DISSECTION OF THE TONGUE.

The tongue is a complex muscular organ, subservient to taste, speech, suction, mastication, and deglutition. Its upper surface is convex and free, as is also its anterior part or tip which lies behind the lower incisor teeth; its posterior and inferior part is connected to the os hyoides by the hyo-glossi, to the styloid process of the temporal bone by the stylo-glossi, and to the symphysis of the lower jaw by the genio-hyo-glossi muscles.

Its upper surface, or *dorsum*, is convex, and slopes on all sides from the centre: running along the middle is a median groove—*raphé*—which terminates posteriorly in a depression, the *foramen cæcum*, into which open several mucous glands.

The surface of the tongue is covered with mucous membrane, which is composed of structures similar to those of the skin generally: that is to say, it consists of a 'cutis vera,' with numerous elevations called papillæ, and of a thick layer of squamous

epithelium. The cutis is much thinner than that of the skin of the body, and affords insertion to some muscular fibres of the tongue.

The mucous membrane on the *under aspect* of the tongue is smooth and comparatively thin, and, in the middle line in front, forms a fold—the *frænum linguæ*—which connects it to the mucous membrane of the floor of the mouth. *Laterally* the mucous membrane is reflected from the under part of the tongue to the lower jaw, and forms the floor of the mouth.

From the posterior part of the tongue the mucous membrane passes to the soft palate on each side, forming the folds termed the *anterior palatine arches*, which enclose the palato-glossi; there are also three folds to the epiglottis, termed the *glosso-epiglottic: two lateral* and *one median*, the latter enclosing a layer of elastic tissue, called the *glosso-epiglottic ligament*. This ligament raises the epiglottis when the tongue is protruded from the mouth; hence the rule of never pulling the tongue forwards when passing a tube into the œsophagus, otherwise the tube might pass into the larynx.

PAPILLÆ OF THE TONGUE. The anterior two-thirds of the tongue are studded with numerous small eminences, called *papillæ*; these, according to their size and form, are distinguished into three kinds—viz. *papillæ circumvallatæ*, *papillæ fungiformæ*, and *papillæ filiformæ* (fig. 39).

The *papillæ circumvallatæ* vary in number from eight to twelve, and are arranged at the back of the tongue in two rows, which converge like the branches of the letter V, with the apex backwards, towards the foramen cæcum. Each of these papillæ is circular, from the $\frac{1}{20}$th to $\frac{1}{12}$th of an inch wide, and slightly broader above than below. Each is surrounded by a circular fossa, which itself is bounded by an elevated ring. The papillæ are covered with a thick stratum of scaly epithelium, beneath which are numerous secondary papillæ. Buried in the epithelium on the side (but not on the upper surface) of these papillæ, numerous flask-shaped bodies, called the *taste buds*, have been discovered. Their bases rest upon the deeper structures, and their apices open upon the surface. According to recent authorities they are in close con-

nection with the ultimate distribution of the glosso-pharyngeal nerve.*

The *papillæ fungiformæ*, smaller and more numerous than the *circumvallatæ*, are scattered chiefly over the sides and tip of the tongue, and sparingly over its upper surface. They vary in shape, some being cylindrical, others having rounded heads like mushrooms; whence their name. Near the apex of the tongue they may be distinguished during life from the other papillæ by their redder colour. In scarlatina, and some exanthematous fevers, these papillæ become elongated, and of a bright red colour: as the fever subsides, their points acquire a brownish tint; giving rise to what is called the strawberry tongue.

FIG. 39.

UPPER SURFACE OF THE TONGUE, WITH THE FAUCES AND TONSILS.

1. Papillæ circumvallatæ.
2. Papillæ fungiformæ.

The *papillæ filiformæ* are the smallest and most numerous. They are so closely aggregated that they give the tongue a velvet-like appearance. Their points are directed backwards, so that the tongue feels smooth if the finger be passed over it from apex to base, but rough if in the contrary direction. These papillæ consist of small conical processes arranged for the most part in a series of lines running parallel to the two rows of the papillæ circumvallatæ. Each papilla is covered with a thick layer of epithelium, which is prolonged into a number of free hairlike processes.

If the papillæ be injected, and examined under the microscope, it is found that they are not simple elevations, like those of the skin, but that from them arise secondary papillæ. The papillæ circumvallatæ consist of an aggregation of smaller papillæ arranged parallel to each other; and the papillæ fungiformæ consist of central stems from which minute secondary papillæ shoot off. This

* For further information about these bodies the student is referred to Engelman-Stracker's 'Handbook.'

elaborate structure escapes observation because it is buried beneath the epithelium.* Each secondary papilla receives a blood-vessel, which passes nearly to its apex, and returns in a loop-like manner.

The papillæ are covered with one or more layers of squamous epithelium. That which covers the filiform is superimposed so thickly as to give it sometimes the appearance of a brush when seen under the microscope. The various kinds of fur on the tongue consist of thick and sodden epithelium.

Respecting the use of the papillæ, it is probable that they enable the tongue to detect impressions with greater delicacy. From the density and arrangement of their epithelial coat, the filiform papillæ give the surface of the tongue a roughness, which is useful in its action upon the food. An apparatus of this kind, proportionately stronger and more developed, makes the tongue of ruminant animals an instrument by which they lay hold of their food. In the feline tribe—*e.g.* the lion and tiger—these papillæ are so sharp and strong that they act like rasps, and enable the animal to lick the periosteum from the bones by a single stroke of his tongue. In some mammalia, they act like combs for cleaning the skin and the hair.

GLANDS.

Numerous small racemose glands are found in the submucous tissue at the root of the tongue. They are similar in structure and secretion to the tonsillar and palatine glands, so that there is a complete ring of glands round the isthmus faucium. Small round orifices upon their surface indicate the termination of their ducts. Other mucous glands, with ducts from one quarter to half an inch long, are situated in the muscular substance of the tongue.

GLANDS BENEATH THE APEX OF THE TONGUE.

On the under surface of the apex of the tongue is placed, on either side, a group of glands presumed to be salivary. Considering each group as one gland, observe that it is oblong, with the long diameter from seven to ten lines, parallel with the axis of the tongue. It lies near the mesial line, a little below the ranine artery, on the outer side of the branches of the gustatory nerve, under some of the

* See Bowman and Todd's 'Physiological Anatomy.'

fibres of the stylo-glossus. Four or five ducts proceed from each group, and terminate by separate orifices on the under surface of the tongue.

MUSCULAR FIBRES OF THE TONGUE.

The substance of the tongue is composed of muscular fibres and of a small quantity of fat. The *extrinsic* muscles of the tongue have been described in the dissection of the submaxillary region (p. 47). We have now to examine its *intrinsic* muscles. For this purpose the mucous membrane must be removed from the dorsum of the tongue. On dissection it will be found that the great bulk of the organ consists of fibres which proceed in a longitudinal direction, constituting the *linguales* muscles.

The *superior lingualis* runs longitudinally beneath the mucous membrane of the dorsum; its fibres are attached posteriorly to the hyoid bone and run forwards to the front and margin of the tongue. Posteriorly the muscle is thin and is covered by the fibres of the palato-glossus and hyo-glossus.

The *inferior lingualis* is larger than the preceding, and is situated on the under aspect of the tongue between the genio-hyo-glossus and the hyo-glossus. It may be readily exposed by dissecting the under surface of the tongue immediately on the outer aspect of the genio-hyo-glossus. It *arises* posteriorly from the hyoid bone and the substance of the tongue, and its fibres pass forwards to the tip of the tongue after being reinforced by fibres from the stylo-glossus.

The *transverse fibres* form a considerable part of the thickness of the tongue and arise from the fibrous septum. They pass outwards between the superior and inferior linguales, ascending as they near the sides of the tongue where the fibres become continuous with those of the palato-glossus. A considerable amount of fat is found among these fibres.

The *vertical fibres* run in a curved direction, descending from the dorsum to the under aspect of the tongue, with the concavity outwards. They interlace with the transverse fibres and with the genio-hyo-glossus.

On tracing the genio-hyo-glossi into the tongue, we find that

some of their fibres ascend directly to the surface; others cross in the middle line, intersect the longitudinal fibres and finally terminate upon the sides of the tongue. Lastly, the fibres of the stylo-glossi should be traced along the side of the tongue to the apex.

FIBROUS SEPTUM OF THE TONGUE. The *fibrous septum* of the tongue is a vertical plane of fibrous tissue which extends, in the mesial line, from the base to the apex. It is connected behind with the hyoid bone, and lost in front between the muscles. In it is sometimes found a piece of fibro-cartilage, called *nucleus fibrosus linguæ*, a representative of the lingual bone in some of the lower animals.

The *arteries* supplying the tongue are the dorsal and ranine branches of the lingual artery (p. 52).

The *nerves* to the tongue should now be followed to their termination. The *hypoglossal* supplies with motor power all the muscles. The *gustatory* or *lingual* branch of the inferior division of the fifth is distributed to the mucous membrane and papillæ of the apex and sides of the tongue, supplying the anterior two-thirds with common sensation. Upon this nerve depends the sensation of all ordinary impressions, such as that of hardness, softness, heat, cold, and the like.

The *glosso-pharyngeal* nerve supplies the mucous membrane at the back and the sides of the tongue, and the papillæ circumvallatæ. Under the microscope small ganglia may be distinguished on the terminal fibres of this nerve.

DISSECTION OF THE ORBIT.

To expose the contents of the orbit, remove that portion of the orbital plate which forms the roof of the orbit as far back as the optic foramen, making one section on the outer side, the other on the inner side of the roof. In doing this, be careful not to injure the little pulley on the inner side for the superior oblique. The anterior fourth of the roof should be turned forwards and downwards,

the remainder removed by bone forceps. The eyeball should be made tense by blowing air through a blow-pipe, passed well into the globe through the end of the optic nerve.

Periosteum of the Orbit. The roof being removed, we expose the fibrous membrane, which lines the walls of the orbit. It is a continuation of the dura mater through the sphenoidal fissure. Traced forwards, we find that at the margin of the orbit it divides into two layers, one of which is continuous with the periosteum of the forehead, the other forms the broad tarsal ligament which fixes the tarsal cartilage.

Fig. 40.

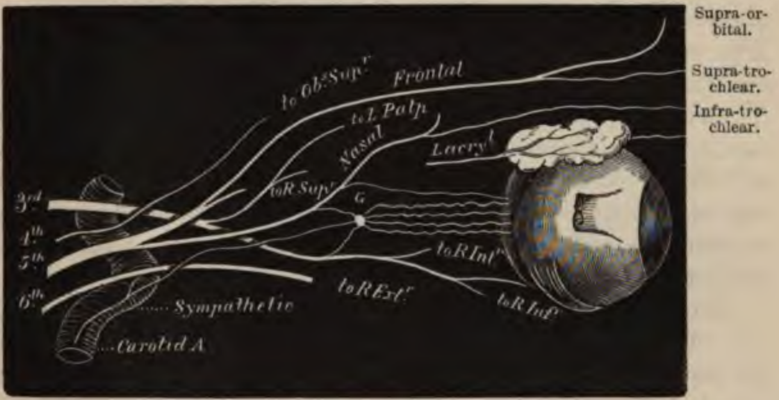


DIAGRAM OF THE NERVES OF THE ORBIT.

Fascia of the Orbit. The fascia of the orbit serves the same purpose that fascia does in other parts. It provides the lachrymal gland, and each of the muscles, with a loose sheath, thin and delicate at the back of the orbit, but stronger near the eye, where it passes from one rectus muscle to the other, so that their tendinous insertions into the globe are connected by it. From the insertion of the muscles it is reflected backwards over the globe of the eye, and the optic nerve, and separates the eye from the fat at the bottom of the orbit.

CONTENTS OF THE ORBIT. There are six muscles to move the eye; four of which, running in a straight direction, are called the *recti*, and are arranged one above, one below, and one on each side of the globe. The remaining two are called, from their direction, *obliqui*, one superior, the other inferior. There is also a muscle to raise the upper eyelid, termed *levator palpebræ*. The *nerves* are: the optic, which passes through the optic foramen; the third, the fourth, the first division of the fifth, and the sixth, all of which pass through the sphenoidal fissure. The third supplies all the muscles with motor power, except the superior oblique, which is supplied by the fourth, and the external rectus, which is supplied by the sixth. The first or ophthalmic division of the fifth divides into a frontal, lachrymal, and nasal branch. The orbit contains, also, a quantity of fat, which forms a soft bed for the eye and prevents it from being retracted too far by its muscles. Upon the quantity of this fat depends, in some measure, the prominence of the eyes. Its absorption in disease or old age occasions the sinking of the eyeballs. The eye is separated from the fat by a fold of the orbital fascia, which, like a tunica vaginalis, enables the globe to move with rapidity and precision. Lastly, the orbit contains the lachrymal gland.

After the removal of the periosteum and the fascia of the orbit, the following objects should be carefully traced. In the middle are seen the *frontal* nerve and artery, lying upon the levator palpebræ; on the inner side is the *fourth* nerve lying on and supplying the superior oblique; on the outer side, the *lachrymal* nerve and artery pass forwards to the lachrymal gland, which lies under cover of the external angular process.

The ophthalmic or first division, of the fifth nerve, after giving off from its inner side, while within the cavernous sinus, the nasal nerve, divides into the lachrymal and frontal nerves, of which the latter is the larger.

FRONTAL NERVE. The frontal nerve runs forwards upon the upper surface of the levator palpebræ, on which, about midway in the orbit, it divides into two branches, the supra-trochlear and the supra-orbital.

a. The *supra-trochlear* runs obliquely inwards above the pulley of

the superior oblique to the inner angle of the orbit. Here it gives off a small communication to the infra-trochlear branch of the nasal, and then divides, after passing between the bone and the orbicularis palpebrarum, into filaments which supply the skin of the upper eyelid, forehead, and nose. One or two small filaments may be traced through the bone to the mucous membrane of the frontal sinuses.*

b. The *supra-orbital* is the continuation of the frontal nerve, and runs forwards to the supra-orbital notch, through which it ascends to supply the skin of the upper eyelid, forehead, and scalp. Its cutaneous branches, an inner and an outer, which run upwards beneath the occipito-frontalis, have been described in the dissection of the scalp (p. 4).

LACHRYMAL NERVE. This is the smallest of the three branches of the ophthalmic nerve. It runs along the outer side of the orbit with the lachrymal artery, through the lachrymal gland, which it supplies as well as the upper eyelid. Its branches within the orbit are: 1, a branch which passes down behind the lachrymal gland to communicate with the orbital branch of the superior maxillary nerve; 2, filaments to the lachrymal gland. It then pierces the palpebral ligament to supply the skin of the upper eyelid.

FOURTH CRANIAL NERVE. This nerve enters the orbit through the sphenoidal fissure above the other nerves. It runs along the inner side of the frontal nerve, and enters the orbital surface of the superior oblique, to which it is solely distributed.†

LACHRYMAL GLAND. This gland is situated below the external angular process of the frontal bone. It is about the size and shape of an almond. Its upper surface is convex, in adaptation to the roof of the orbit; its lower is concave, in adaptation to the eyeball. The anterior part of the gland lies sometimes separated from the rest, close to the back part of the upper eyelid, and is covered by the conjunctiva. The whole

* These filaments have been described by Blumenbach—'De sinibus Frontal.'

† This nerve is joined in the outer wall of the cavernous sinus by filaments from the sympathetic. Here also it sends backwards two or more filaments to supply the tentorium cerebelli.

gland is invested by a capsule* formed by the fascia of the orbit.

The lachrymal gland consists of an aggregation of small lobes composed of smaller lobules, connected by fibro-cellular tissue, and resembles the structure of the salivary glands. The excretory ducts, seven to ten in number, run parallel, and perforate the conjunctiva about a quarter of an inch above the edge of the tarsal cartilage (fig. 41). They are not easily discovered in the human eye; in that of the horse or bullock they are large enough to admit a small probe. The secretion of the gland keeps the surface of the cornea constantly moist and polished; but if dust, or any foreign substance, irritate the eye, the tears flow in abundance, and wash it off.

Fig. 41.

All the muscles of the orbit, with the exception of the inferior oblique, arise from the margin of the foramen opticum, and saps forwards, like ribands, to their insertions.

Levator Palpebræ. This muscle *arises* from the roof of the orbit, above and in front of the optic foramen. It gradually increases in breadth, and terminates in a broad, thin aponeurosis, which is *inserted* into the upper surface of the tarsal cartilage beneath the palpebral ligament. It is constantly in action when the eyes are open, in order to counteract the tendency of the lids to fall. As sleep approaches, the muscle relaxes, the eyes feel heavy, and the lids close. Its nerve comes from the superior division of the third nerve, and enters it on its under or ocular aspect.

* This capsule, being a little stronger on the under surface of the gland, is described and figured by Sœmmerring as a distinct ligament, 'Icones Oculi Humani,' tab. vii.

OBLIQUUS SUPERIOR. This muscle *arises* from the inner side of the foramen opticum. It runs along the inner side of the orbit, and terminates in a round tendon, which passes through a cartilaginous pulley—*trochlea*—attached to the anterior and inner part of the roof of the orbit. From this pulley the tendon is reflected outwards and backwards to the globe of the eye. It gradually expands, and is *inserted* into the outer and back part of the sclerotic coat, between the external and superior recti. The pulley is lined by a synovial membrane, which is continued upon the tendon. The *action* of this muscle will be considered with that of the inferior oblique (p. 217). It is supplied by the fourth nerve, which enters the back part of its upper surface.

The frontal nerve and levator palpebræ should now be cut through the middle and reflected, to expose the superior rectus muscle.

FOUR RECTI MUSCLES. These four muscles have a tendinous origin round the foramen opticum, so that, collectively, they embrace the optic nerve. They diverge from each other, one above, one below, and one on each side of the optic nerve; and are named, accordingly, *rectus superior*, *inferior*, *externus*, and *internus*. Their broad thin tendons are *inserted* into the sclerotic coat of the eye, about a quarter of an inch from the margin of the cornea (fig. 42).

The *external* rectus not only arises from the circumference of the optic foramen, but has another origin from the lower margin of the sphenoid fissure. Between these origins pass the third nerve, the nasal branch of the fifth, the sixth, and the ophthalmic vein.

The recti muscles enable us to direct the eye towards different points; hence the names given to them by Albinus—attollens, depressor, adductor, and abductor oculi. It is obvious that by the single action of one, or the combined action of two, the eye can be turned towards any direction.

The rectus superior is supplied by the upper division of the third nerve; the rectus internus, the rectus inferior and obliquus inferior, by the lower division. The rectus externus is supplied by the sixth.

Follow the recti to the eye, in order to see the tendons by which they are inserted. Notice also the anterior ciliary arteries, which run to the eye along the tendons. The congestion of these little vessels occasions the red zone round the cornea in iritis. It has been already mentioned that the tendons are invested by a fascia, which passes from one to the other, forming a loose tunic—*capsule of Tenon*—over the back of the eye. This tunic consists of two layers with an intermediate space, lined with flat cells, thus allowing free mobility of the globe. It is this fascia which resists the passage of the hook in the operation for the cure of squinting. Even after the complete division of the tendon, the eye may still be held in its faulty position, if this tissue, instead of possessing its proper softness and pliancy, happen to have become contracted and unyielding. Under such circumstances it is necessary to divide it freely with the scissors.

Fig. 42.

INSERTION OF THE RECTI MUSCLES WITH THE ANTERIOR CILIARY ARTERIES.

By removing the conjunctival coat of the eye, the tendons of the recti are soon exposed. The breadth and the precise situation of their insertion deserve attention in reference to the operation for strabismus. The breadth of their insertion is about three-eighths of an inch, but the line of this insertion is not, at all points, equidistant from the cornea. The centre of the insertion is nearer to the cornea by about one line than either end. Taking the internal rectus, which has most frequently to be divided in strabismus, we find that the centre of its tendon is, upon an average, three lines only from the cornea, the lower part nearly five lines, and the upper four. It is, therefore, very possible that the lower part may be left undivided in the operation, being more in the background than the rest. The tendon of the internal rectus is nearer to the cornea than either of the others.

The superior rectus should now be reflected: in doing so, observe the branch from the upper division of the third nerve, which supplies it and the levator palpebræ. After the removal of a quantity of fat, we expose the following objects:—1, the optic nerve; 2, the nasal nerve, the ophthalmic artery and vein, all of which cross obliquely over the optic nerve from without inwards; 3, the inferior division of the third nerve; 4, deeper, towards the back of the orbit, between the optic nerve and the external rectus, is situated the *ophthalmic* or *lenticular ganglion* with its ciliary branches; 5, the sixth nerve entering the ocular aspect of the rectus externus.

NASAL NERVE. This is one of the three divisions of the ophthalmic branch of the fifth pair (fig. 40, p. 207). It enters the orbit through the sphenoidal fissure between the two origins of the external rectus, and then crosses obliquely over the optic nerve, beneath the levator palpebræ and the superior rectus, towards the inner wall of the orbit. After giving off the *infra-trochlear* branch, the nerve passes out of the orbit between the superior oblique and internal rectus, through the anterior ethmoidal foramen, into the cranium, where it lies beneath the dura mater, upon the cribriform plate of the ethmoid bone. It soon leaves the cranium through the nasal slit near the crista galli, and enters the nose. Here it sends filaments to the mucous membrane of the upper part of the septum, and superior spongy bone; but the main continuation of the nerve runs behind the nasal bone, becomes superficial between the bone and the cartilage, and, under the name of *naso-lobular*, is distributed to the skin of the ala and tip of the nose (p. 74).

The nasal nerve gives off the following branches in the orbit:—

a. One slender filament to the *lenticular ganglion* (forming its upper or long root) is given off from the nasal nerve as it passes between the heads of the external rectus. It is about half an inch long, and enters the posterior-superior angle of the ganglion.

b. Two or three *long ciliary nerves*. They run along the inner side of the optic nerve to the back of the globe of the eye. They are joined

by filaments from the lenticular ganglion, and pass through the sclerotic coat to supply the iris.

c. *Infra-trochlear nerve.*—This runs below the pulley of the superior oblique, where it communicates with the supra-trochlear branch of the frontal nerve. It then divides into filaments, which supply the skin of the eyelids, the lachrymal sac, the caruncle, and the side of the nose.

OPTIC NERVE. This nerve, having passed through the optic foramen, proceeds forwards and a little outwards to the globe of the eye, which it enters on the nasal side of its axis. It then expands to form the retina. The nerve is invested by a fibrous coat derived from the dura mater. At the optic foramen it is surrounded by the tendinous origins of the recti; in the rest of its course, by loose fat and by the ciliary nerves and arteries. It is pierced in its course through the orbit by the arteria centralis retinæ which runs in the middle of the nerve to the eyeball.

OPHTHALMIC ARTERY. This artery arises from the internal carotid. It enters the orbit through the optic foramen, outside the optic nerve; occasionally through the sphenoidal fissure. Its course in the orbit is remarkably tortuous. Situated at first on the outer side of the optic nerve, it soon crosses over it, and runs along the inner side of the orbit, to inosculate with the internal angular artery (the terminal branch of the facial). Its branches arise in the following order:—

a. *Lachrymal artery.*—This branch proceeds along the outer wall of the orbit to the lachrymal gland. After supplying the gland, it terminates in the upper eyelid. It anastomoses with the deep temporal arteries, and with a branch from the arteria meningea media.

b. *Supra-orbital artery.*—This branch runs forwards with the frontal nerve under the roof of the orbit, and emerges on the forehead through the supra-orbital notch. It inosculates chiefly with the superficial temporal artery.

c. *Arteria centralis retinæ.*—This small branch enters the optic nerve on the outer aspect, and runs in the centre of this nerve to the interior of the eye.

d. *Ciliary arteries.*—These branches proceed tortuously forwards with the optic nerve. They vary from twelve to fifteen in number, and perforate the sclerotic coat at the back of the eye, to supply the choroid

coat and the iris. They are sometimes called *short ciliary*, to distinguish them from the *long ciliary*, two in number, which run on each side of the optic nerve, enter the sclerotic, and extend horizontally forwards, one on each side of the globe, between the sclerotic and choroid coats, to the ciliary muscle and iris. The *anterior ciliary* are branches of the muscular arteries, and proceed with the tendons of the recti, and enter the front part of the sclerotic coat. In inflammation of the iris the vascular zone round the cornea arises from enlargement and congestion of the anterior ciliary arteries.

e. Ethmoidal arteries.—Of these arteries, two in number, the *anterior* and larger passes through the anterior ethmoidal foramen with the nasal nerve; the *posterior* enters the posterior ethmoidal foramen. Both give off anterior meningeal branches to the dura mater, and supply the mucous membrane of the nose, and of the ethmoidal cells.

f. Muscular arteries.—These are uncertain in their origin, and give off the anterior ciliary branches.

g. Palpebral arteries.—These branches, a *superior* and an *inferior* proceed from the lachrymal, nasal, and supra-orbital arteries, and are distributed to their respective eyelids, forming arches near the margin of the lids between the tarsal cartilages and the orbicularis palpebrarum.

h. Nasal artery.—This branch may be considered one of the terminal divisions of the ophthalmic. It leaves the orbit on the nasal side of the eye above the tendon of the orbicularis, and inosculates with the angular artery (termination of the facial). It supplies the side of the nose and the lachrymal sac.

i. Frontal artery.—This is the other terminal branch of the ophthalmic. It emerges at the inner angle of the eye, ascends, and inosculates with the supra-orbital artery.

Ophthalmic Vein. This commences at the inner angle of the eye, by a communication with the frontal and angular veins. It runs backwards above the optic nerve in a straighter course than the artery, receives corresponding branches, and finally passes between the two heads of the external rectus, to terminate in the cavernous sinus.

Ophthalmic or Lenticular Ganglion. This small ganglion (G, fig. 40, p. 207), of reddish colour, and about the size of a pin's head, is situated at the back part of the orbit, between the optic nerve and the external rectus. It receives a *sensory* branch

from the nasal nerve, which joins its posterior superior angle; a *motor* branch (from the lower division of the third), which enters its posterior inferior angle; and it receives a filament from the sympathetic plexus round the internal carotid artery. The ganglion thus furnished with motor, sensory, and sympathetic roots, gives off the *short ciliary nerves.* They run forward very tortuously with the optic nerve, pass through the back of the sclerotic coat, where they are joined by the long ciliary (from the nasal), and are distributed to the iris and the ciliary muscle. Since the ciliary nerves derive their motor influence from the third nerve, the iris must lose its power of contraction when this nerve is paralysed.

THIRD NERVE, MOTOR OCULI. The third nerve, just before it enters the sphenoidal fissure, divides into two branches, both of which pass between the origins of the external rectus. The *upper* division has been already traced into the superior rectus and levator palpebræ. The *lower* division supplies a branch to the internal rectus, another to the inferior rectus, and then runs along the floor of the orbit to the inferior oblique muscle (fig. 40).

What is the result of paralysis of the third nerve? Falling of the upper eyelid (ptosis), external squint, dilatation and immobility of the pupil.

SIXTH NERVE, MOTOR EXTERNUS. This nerve enters the orbit between the origins of the external rectus above the ophthalmic vein, and terminates in fine filaments, which are exclusively distributed to the ocular surface of this muscle.

Respecting the motor nerves in the orbit, observe that they all enter the ocular surface of the muscles, with the exception of the fourth which enters the orbital surface of the superior oblique.

INFERIOR OBLIQUE. This muscle *arises* by a flat tendon from the orbital plate of the superior maxilla on the outer side of the lachrymal groove. It runs outwards and backwards between the orbit and the inferior rectus, then curves upwards between the globe and the external rectus, and is *inserted* by a broad thin tendon into the outer and back part of the sclerotic, close to the tendon of the superior oblique. It is supplied by the lower division of the third nerve.

Action of the Oblique Muscles of the Eye. The action of the oblique muscles of the eye will be understood if a mark in the iris be watched while the head is rotated from side to side on its antero-posterior axis. It will be thus seen that the eye does not rotate on its antero-posterior axis, as might have been expected. This is due to the oblique muscles (the right superior acting with the left inferior, and *vice versâ*) which prevent the rotation of the eye on its antero-posterior axis during the movements of the head. In other words, they keep the vertical meridian of the eye always vertical.

Tensor Tarsi. This muscle is only a deeper part of the orbicularis palpebrarum. To expose it, cut perpendicularly through the middle of the upper and lower lids, and evert the inner halves toward the nose. After removing the mucous membrane, the muscle will be seen *arising* from the ridge of the lachrymal bone. It passes nearly horizontally outwards and divides into two portions, which are *inserted* into the upper and lower tarsal cartilages, close to the orifices of the lachrymal ducts. It is probable that the tensor tarsi draws backwards the open mouths of the ducts, so that they may receive the tears at the inner angle of the eye. It is supplied by a small branch from the facial nerve.

Orbital Branch of the Superior Maxillary Nerve. This is always very small, and is sometimes absent. It comes from the trunk of the superior maxillary in the spheno-maxillary fossa (fig. 43), enters the orbit through the spheno-maxillary fissure, and divides into two branches. Of these, one, the *temporal*, lies in a groove in the outer wall of the orbit, and after sending a small branch to the lachrymal nerve in the orbit, passes through a foramen in the malar bone to the temporal fossa. It then pierces the temporal aponeurosis an inch above the zygoma, and supplies the skin of the temple, joining frequently with the auriculo-temporal branch of the inferior maxillary. The other branch, the *malar*, passes along the outer part of the floor of the orbit, embedded in fat, and makes its exit through a foramen in the malar bone, to supply the skin of the cheek (p. 94).

DISSECTION OF THE SUPERIOR MAXILLARY NERVE.

To trace this nerve and its branches we must remove the outer wall of the orbit as far as the foramen rotundum, so as to expose the spheno-maxillary fossa.

The superior maxillary nerve is the second division of the fifth cranial nerve. Proceeding from the Gasserian ganglion (fig. 43),

Fig. 43.

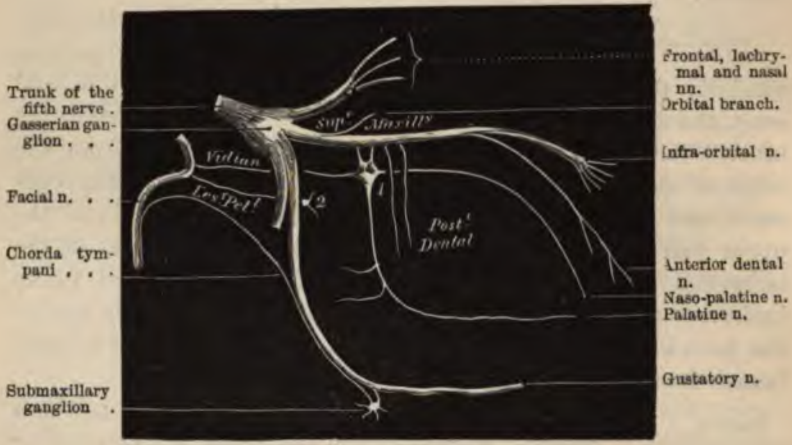


DIAGRAM OF THE SUPERIOR MAXILLARY NERVE.

1. Spheno-palatine ganglion. 2. Otic ganglion.

it leaves the skull through the foramen rotundum, and passes horizontally forwards across the spheno-maxillary fossa. It then passes into the orbit through the spheno-maxillary fissure, enters the infra-orbital canal with the corresponding artery, and finally emerges upon the face, through the infra-orbital foramen, beneath the levator labii superioris. The branches given off are :—

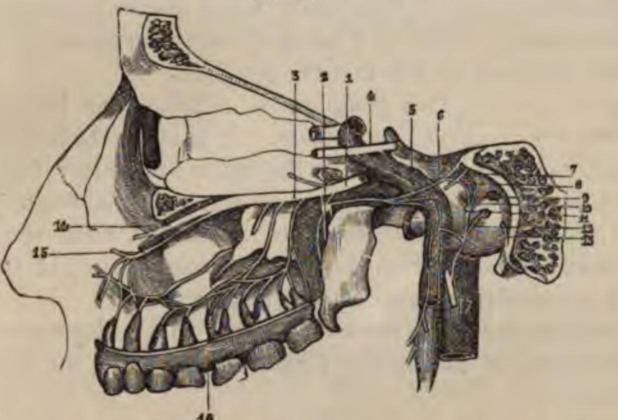
a. The *orbital* branch already described (p. 217).

b. Two branches, which descend to the *spheno-palatine ganglion* (Meckel's), situated in the spheno-maxillary fossa (p. 220).

c. Posterior dental branches, two in number. They descend along the back part of the superior maxillary bone. One lies between the periosteum and the bone, and supplies the gums and mucous membrane; the other passes through a foramen in company with a small artery, and running in an osseous canal supplies the molar teeth and the antrum; it gives off also a small branch which communicates with the anterior dental nerve.

d. Anterior dental branch.—This is given off just before the nerve emerges from the infra-orbital foramen. It descends in a special canal

FIG. 44.



DEEP VIEW OF THE SPHENO-PALATINE GANGLION, AND ITS CONNECTION WITH OTHER NERVES. (After Hirschfeld.)

1. Superior maxillary n.
2. Spheno-palatine ganglion, from the lower part of which are seen proceeding the palatine nerves.
3. Posterior superior dental brs.
4. Sixth n. receiving two filaments from the carotid plexus of the sympathetic n.
5. The carotid br. of the Vidian.
6. The great petrosal br. of the Vidian.
7. Lesser petrosal nerve.
8. External deep petrosal n., uniting with lesser petrosal n.
9. The internal deep petrosal nerve joining the great petrosal nerve.
10. Filament to fenestra ovalis.
11. Filament to Eustachian tube.
12. Filament to fenestra rotunda.
13. Chorda tympani.
14. Infra-orbital nerve.
15. Anterior dental n.
16. Junction of posterior and anterior dental filaments.
17. Glosso-pharyngeal n. giving off tympanic branch.

in the anterior wall of the upper jaw, and divides into branches, which distribute filaments to the incisor, canine, and bicuspid teeth, the mucous membrane of the antrum and the gums.

e. The terminal branch, the *infra-orbital,* was dissected with the face (p. 93).

DISSECTION. At this stage of the dissection, make a vertical incision rather on one side of the middle line of the skull, to expose the cavity of the nose. Thus, by searching for the spheno-palatine foramen, we are enabled to expose the spheno-palatine ganglion. This may be readily made out by tracing the terminal branch of the internal maxillary artery which comes through the foramen into the nose. The student should next cut away the thin plate of bone which forms the inner boundary of the palatine canal. Then, by tracing upwards the branches contained within the canal, he will find the ganglion.

SPHENO-PALATINE GANGLION. This ganglion is called, after its discoverer, *Meckel's ganglion.* It is about the fifth of an inch in diameter. It is situated in the spheno-maxillary fossa, immediately on the outer side of the spheno-palatine foramen. Like other ganglia, it has three roots, a *sensory,* from the superior maxillary; a *motor,* from the great petrosal branch of the facial; and a *sympathetic,* from the carotid plexus.

Its branches pass upwards to the orbit; downwards to the palate; inwards to the nose; and backwards to the pharynx, as follows:—

a. Ascending branches.—These are very small, and run through the spheno-maxillary fissure to be distributed to the periosteum of the orbit.*

b. Descending branches.—To see these the mucous membrane must be removed from the back part of the nose: we shall then be able to trace the nerves through their bony canals. Their course is indicated by their accompanying arteries. They descend through the palatine canals, and are three in number. The *anterior palatine* nerve, the largest, descends through the posterior palatine canal to the roof of the mouth, and then divides into branches, which run in grooves in the hard palate nearly to the gums of the incisor teeth, where it communicates with the

* Anatomists describe several branches ascending from the ganglion, one to join the sixth nerve, another to join the ophthalmic ganglion, and, lastly, some to join the optic nerve through the ciliary branches.

naso-palatine nerve. Within its canal it sends two *nasal branches* which supply the membrane on the middle and lower spongy bones. The *smaller palatine* descends in the same canal with the anterior, or in a smaller one of its own, and supplies the mucous membrane of the soft palate, the tonsil, and (according to Meckel) the levator palati muscle.* The *external palatine* may be traced in a special canal down to the soft palate, where it terminates in branches to the uvula, the palate, and tonsil.

c. Internal branches.—These, three or four in number, pass through the spheno-palatine foramen to the mucous membrane of the nose. To see them clearly, the parts should have been steeped in dilute nitric acid; afterwards, when well washed, these minute filaments may be recognised beneath the mucous membrane covering the spongy bones. The *upper nasal* branches pass inwards, and are distributed on the two upper spongy bones, the upper and back part of the septum and the posterior ethmoidal cells. The *naso-palatine* traverses the roof of the nose, distributes branches to the back part of the septum narium, and then proceeds obliquely forwards, along the septum, to the foramen incisivum, through which it passes, and finally terminates in the palate behind the incisor teeth communicating here with the anterior palatine nerve.

d. Posterior branches.—The *pharyngeal nerve*, very small, comes off from the back of the ganglion, and, after passing through the pterygo-palatine canal with its corresponding artery, supplies the mucous membrane of the back of the pharynx and the Eustachian tube. The *Vidian nerve* is the principal branch. It proceeds backwards from the posterior part of the ganglion, through the Vidian canal. It then traverses the fibro-cartilage of the foramen lacerum medium, and divides into two branches. Of these two branches, one—the *carotid*—joins the sympathetic plexus on the outer side of the internal carotid artery; the other, the *great petrosal*, enters the cranium, and runs beneath the Gasserian ganglion and the dura mater in a small groove on the anterior surface of the petrous bone: it then enters the hiatus Fallopii, and joins the facial nerve in the aquæductus Fallopii.

* According to Longet ('Anat. et Physiol. du Système Nerveux,' Paris, 1842), the posterior palatine nerve supplies the levator palati and the azygos uvulæ with motor power. In this view of the subject the nerve is considered to be the continuation or terminal branch of the motor root of the ganglion: that, namely, derived from the facial. This opinion is supported by cases in which the uvula is stated to have been drawn on one side in consequence of paralysis of the opposite facial nerve.

It would seem to be more in accordance with modern views to regard the Vidian nerve, not as dividing to form the carotid and great superficial petrosal branches, but rather as formed by the junction of these branches. In this view, the Vidian runs, not *from*, but *to* the spheno-palatine ganglion.

OTIC GANGLION.

The otic ganglion is situated on the inner side of the inferior maxillary division of the fifth nerve, immediately below its exit through the foramen ovale (fig. 44). Its inner surface is in contact with the circumflexus palati muscle and the cartilage of the Eustachian tube, and immediately behind it is the middle meningeal artery. It is always small.*

This ganglion has branches of connection with other nerves: namely,—a *sensory* from the auriculo-temporal nerve; a *motor* from the branch of the inferior maxillary which goes to the internal pterygoid muscle; and a *sympathetic* from the plexus around the arteria meningea media. It communicates also with the facial and the glosso-pharyngeal nerves by the *lesser petrosal* nerve. This branch passes backwards either through the foramen ovale or the foramen spinosum, or through a small hole between them, and runs beneath the dura mater in a minute groove on the petrous bone, external to that for the *great petrosal* nerve. Here it divides into two filaments, one of which joins the facial nerve in the aquæductus Fallopii, the other joins the tympanic branch of the glosso-pharyngeal. These nerves are difficult to trace, not only on account of their minuteness, but because they frequently run in canals in the temporal bone.

The otic ganglion sends a branch forwards to the tensor palati, and one backwards to the tensor tympani.

* J. Arnold. 'Diss. inaug. med.,' &c. Heidelbergæ, 1826.

FIG. 45.

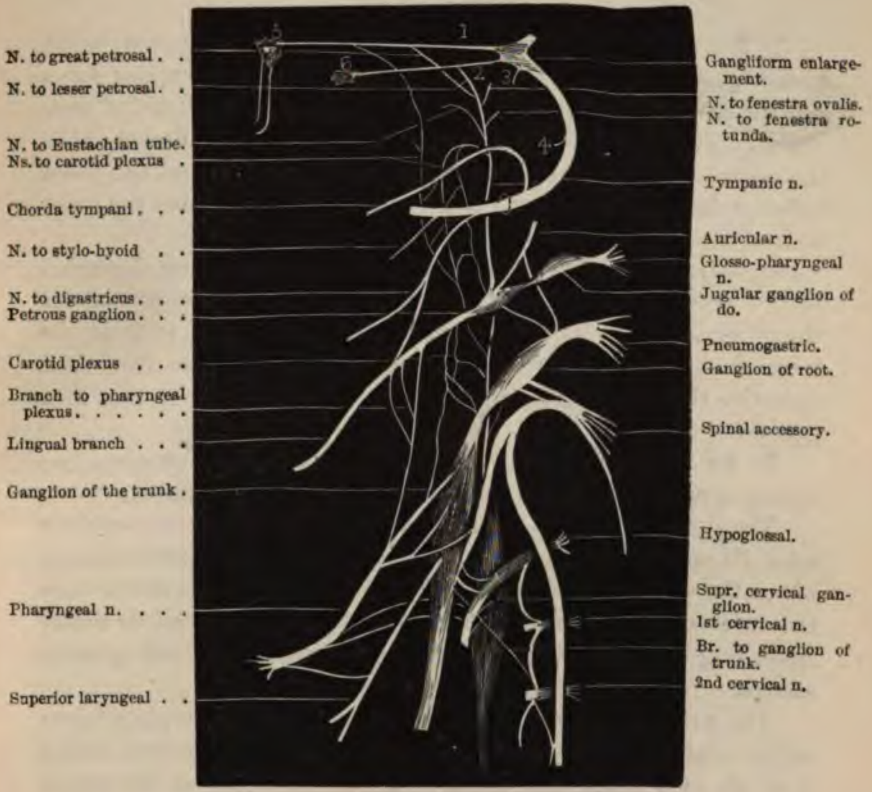


DIAGRAM OF THE COMMUNICATIONS OF THE FACIAL, GLOSSO-PHARYNGEAL, PNEUMOGASTRIC, SPINAL ACCESSORY, HYPOGLOSSAL, SYMPATHETIC, AND THE TWO UPPER CERVICAL NERVES.

1. Great petrosal nerve.
2. Lesser do.
3. External do.
4. Nerve to Stapedius muscle.
5. Spheno-palatine ganglion.
6. Otic ganglion.

DISSECTION OF THE EIGHTH PAIR OF NERVES AT THE BASE OF THE SKULL.

In this dissection we propose to examine the glosso-pharyngeal, pneumogastric, and spinal accessory nerves in the jugular fossa, and the ganglia and nerves belonging to them in this part of their course. These are difficult to trace, and cannot be followed unless the nerves have been previously hardened by spirit, and the bones softened in acid. The next thing to be done is to remove the outer wall of the jugular fossa.

GLOSSO-PHARYNGEAL NERVE. This nerve emerges from the cranium through a separate tube of dura mater, in front of that for the other two nerves of the eighth pair. Looking at it from the interior of the skull, we notice that it is situated in front and rather to the inner side of the jugular fossa, where it lies in a groove.

In its passage through the foramen, the nerve presents two enlargements, termed the *jugular* and the *petrous* ganglia.

The *jugular ganglion** is found upon the nerve immediately after its entrance into the canal of the dura mater, and averages about the $\frac{1}{20}$ of an inch in length and breadth. It is situated on the outer side of the nerve, and does not implicate all its fibres. According to our observation, this ganglion is not infrequently absent.

The *petrous ganglion*† is situated upon the glosso-pharyngeal nerve, near the lower part of the jugular fossa. It is oval, about $\frac{1}{4}$ of an inch long, and involves all the filaments of the nerve. It is connected by filaments with the pneumogastric and sympathetic nerves, and it gives off the tympanic nerve.‡ The branches which connect this ganglion with the pneumogastric are, one to its auricular branch, and a second to the ganglion of the root. It is also connected with the sympathetic by a small fila-

* Müller, 'Medicin. Zeitung,' Berlin, 1833. No. 52.

† Andersch, 'Fragm. Descript. Nerv. Cardiac.' 1791.

‡ This nerve, though commonly called Jacobson's, was fully described by Andersch.

ment from the superior cervical ganglion. The *tympanic nerve* ascends through a minute canal in the bony ridge which separates the carotid from the jugular fossa to the inner wall of the tympanum, where it terminates in six small filaments. Of these three are branches of distribution, and three of connection with other nerves. The *branches of distribution* are, one each to the fenestra rotunda and the fenestra ovalis, and one to the Eustachian tube. The *connecting branches* are two small filaments, which traverse a bony canal to join the plexus on the outer side of the carotid artery: the second ascends in front of the fenestra ovalis and joins the great petrosal nerve in the hiatus Fallopii; the third takes nearly a similar course, and under the name of the lesser petrosal nerve proceeds along the front surface of the pars petrosa to the otic ganglion. Thus this tympanic branch is distributed to the mucous membrane of the tympanum and the Eustachian tube, and communicates with the spheno-palatine ganglion through the great petrosal nerve, and with the otic ganglion through the lesser petrosal.

PNEUMOGASTRIC NERVE. This nerve leaves the cranium with the nervus accessorius through a common canal in the dura mater, behind that for the glosso-pharyngeal. At its entrance into the canal, it is composed of a number of separate filaments which are soon collected into a single trunk. In the jugular foramen, the nerve presents a ganglionic enlargement, called the *ganglion of the root* of the pneumogastric. This ganglion* is about $\frac{1}{7}$ of an inch in length. It is connected by filaments with the sympathetic through the superior cervical ganglion, with the petrous ganglion of the glosso-pharyngeal, with the facial, and with the spinal accessory by one or two branches. It gives off the *auricular branch*,† which is distributed to the pinna of the ear. This branch shortly after its origin is joined by a branch from the glosso-pharyngeal, and enters a minute foramen in the jugular fossa near the styloid process. It then proceeds through a canal in the bone, crosses the aquæductus Fallopii, and passes to the

* Arnold, 'Der Kopftheil des Veget. Nerven Systems.' Heidelberg, 1831.
† Arnold's nerve.

outside of the head through the fissure between the mastoid process and the meatus auditorius externus. It is distributed to the skin of the auricle and communicates with the posterior auricular branch of the facial nerve.

FACIAL NERVE IN THE TEMPORAL BONE.

The facial nerve is contained within the meatus auditorius internus, together with the auditory nerve. At the bottom of the meatus the two nerves are connected by one or more filaments. The facial nerve then enters the aquæductus Fallopii. This is a tortuous canal in the substance of the temporal bone, and terminates at the

FIG. 46.

1. The chorda tympani.
2. The geniculate ganglion of the facial nerve.
3. The great petrosal nerve.
4. The lesser petrosal nerve lying over the tensor tympani.

5. The external petrosal nerve communicating with the sympathetic plexus on the arteria meningea media (6).
7. The Gasserian ganglion.

THE GENICULATE GANGLION OF THE FACIAL NERVE, AND ITS CONNECTIONS WITH THE OTHER NERVES. (From Bidder.)

stylo-mastoid foramen. The nerve proceeds from the meatus internus for a short distance outwards, where it presents a ganglionic enlargement; it then makes a sudden bend backwards along the inner wall of the tympanum above the fenestra ovalis, and lastly, curving downwards along the back of the tympanum, it leaves the skull through the stylo-mastoid foramen. Its branches in the temporal bone are :—

a. Communicating filaments with the auditory nerve, in the meatus auditorius internus.

b. The great petrosal nerve, which runs to the spheno-palatine ganglion. (Fig. 46. 3.)

c. The lesser petrosal nerve, which runs to the otic ganglion. (Fig. 46. 4.)

d. The external petrosal, which connects the facial nerve with the sympathetic plexus around the middle meningeal artery. (Fig. 46. 5.)

e. The nerve to the Stapedius muscle, which runs in the pyramid. (Fig. 45. 4.)

f. The chorda tympani, which joins the submaxillary ganglion.

The *chorda tympani* is given off from the facial nerve before its exit from the stylo-mastoid foramen. It ascends a short distance in a bony canal at the back of the tympanum, and enters that cavity below the pyramid, close to the membrana tympani. It runs forward, ensheathed in mucous membrane, through the tympanum, between the handle of the malleus and the long process of the incus, to the anterior part of that cavity. It then traverses a special bony canal,* and emerges from the tympanum external to the fissura Glaseri. It subsequently joins the lower border of the gustatory nerve at an acute angle, and proceeds to the submaxillary ganglion. It is said to supply the laxator tympani muscle.†

COURSE OF INTERNAL CAROTID THROUGH BASE OF SKULL.

The internal carotid takes a very tortuous course through the base of the skull before it reaches the brain. It makes no less than four curves. It first curves forwards and inwards through the carotid canal of the temporal bone; it makes a second curve upwards through the cartilage in the foramen lacerum medium; it then makes a third curve forwards on the side of the body of the sphenoid; and, lastly, a fourth curve upwards on the inner side of the anterior clinoid process, after which it enters the cranial cavity, gives off the ophthalmic, and divides into the anterior cerebral, the middle cerebral, and the posterior communicating arteries.

The internal carotid is accompanied in the carotid canal by the cranial branch of the superior cervical ganglion of the sympathetic, described p. 115. Its position on the inner wall of the

* Canal of Huguier.

† This is probably not muscular, but ligamentous in structure.

cavernous sinus, and the nervous plexuses upon it are described a p. 16.

In the carotid canal the artery gives off a small branch to the masto cells and the tympanum.

At this stage of the dissection we may conveniently trace th anterior divisions of the two upper cervical nerves.

Suboccipital Nerve. The anterior division of the *first cervical* o *suboccipital nerve* descends in front of the trans verse process of the atlas to form a loop with the second cervica nerve. It lies beneath the vertebral artery, on the inner side o the rectus capitis lateralis to which it gives a branch; and from its loop of communication with the second nerve, it gives branche to the recti antici muscles. This nerve is connected by filament with the superior cervical ganglion of the sympathetic, with th hypoglossal and the pneumogastric nerves.

Second Cervical Nerve. The anterior division of this nerve emerges be tween the arches of the atlas and axis, and passe between the vertebral artery and the intertransverse muscle, i front of which it sub-divides into an ascending branch which join the first cervical nerve, and a descending, which joins the thir cervical nerve.

DISSECTION OF THE NOSE.

Presuming that the dissector is familiar with the bones com posing the skeleton of the nose, we shall now describe, 1. Th nasal cartilages; 2. The general figure and arrangement of th nasal cavities; 3. The membrane which lines them; and, 4. Th distribution of the olfactory nerves.

Cartilages of the Nose. The framework of the external nose is formed on each side, by two lateral cartilages; and by one in the centre, which completes the septum between the nasa fossæ.

The *lateral cartilages* are termed, respectively, upper and lower. The *upper*, triangular in shape, is connected, superiorly, t

the margin of the nasal and superior maxillary bones; anteriorly to the cartilage of the septum, and, inferiorly, to the lower cartilage by means of a tough fibrous membrane. The *lower* is elongated, and curved upon itself in such a way as to form not only half the apex but the lateral boundary of the external opening of the nostrils. Superiorly, it is connected by fibrous membrane to the upper cartilage; internally, it is in contact with its fellow of the opposite side, forming the upper part of the columna nasi; posteriorly, it is attached by fibrous tissue to the superior maxillary bone: in this tissue, at the base of the ala, are usually found two or three nodules of cartilage, called *cartilagines sesamoideæ*. By their elasticity these several cartilages keep the nostrils continually open, and restore them to their ordinary size whenever they have been expanded by muscular action.

The *cartilage of the septum* is placed perpendicularly in the middle line: it may lean a little, however, to one side or the other, and in some instances it is perforated, so that the two nasal cavities communicate with each other. The cartilage is smooth and flat, and its outline is nearly triangular. The posterior border is received into a groove in the perpendicular plate of the ethmoid; the anterior border is much thicker than the rest of the septum, and is connected, superiorly, with the nasal bones, and on either side with the lateral cartilages. The inferior border is attached to the vomer and the median ridge at the junction of the palatine processes of the superior maxillæ.

The muscles moving the nasal cartilages have been described with the dissection of the face (p. 82).

INTERIOR OF THE NOSE. A vertical section should be made through the right nasal cavity, a little on the same side of the middle line, to expose the partly bony and partly cartilaginous partition of the nasal cavities (*septum narium*). Each nasal fossa is narrower above than below. The greatest perpendicular depth of each fossa is about the centre; from this point the depth gradually lessens towards the anterior and the posterior openings of the nose. Laterally, each fossa is very narrow in consequence of the projection of the spongy bones towards the septum: this

narrowness in the transverse direction explains the rapidity with which swelling of the lining membrane from a simple cold obstructs the passage of air.

BOUNDARIES OF NASAL FOSSÆ. The nasal fossæ are bounded by the following bones:—*superiorly*, by the nasal, the nasal spine of the frontal, the cribriform plate of the ethmoid, and the body of the sphenoid; *inferiorly*, by the horizontal plates of the superior maxillary and palate bones; *internally*, is the smooth and flat septum formed by the perpendicular plate of the ethmoid, the ridge formed by the two nasal bones, the vomer, the septal cartilage, also by the nasal spine of the frontal, the rostrum of the sphenoid, and the median ridge of the superior maxillary and palate bones; *externally*, by the superior maxillary, the lachrymal, the ethmoid, the palate, the inferior turbinated bone, and the internal pterygoid plate of the sphenoid.

MEATUSES OF THE NOSE. The outer wall of each nasal cavity is divided by the turbinated bones into three compartments—*meatuses*—of unequal size; and in these are orifices leading to air-cells—*sinuses*—in the sphenoid, ethmoid, frontal, and superior maxillary bones. Each of these compartments should be separately examined.

a. The *superior meatus* is the smallest of the three, and does not extend beyond the posterior half of the wall of the nose. The posterior ethmoidal and sphenoidal cells open into it. The spheno-palatine foramen is covered by the mucous membrane.

b. The *middle meatus* is larger than the superior. At its anterior part a long narrow passage (*infundibulum*), nearly hidden by a fold of membrane, leads upwards to the frontal and the anterior ethmoidal cells. About the middle a small opening leads into the antrum of the superior maxilla: this opening in the dry bone is large and irregular, but in the recent state it is reduced nearly to the size of a crow-quill by mucous membrane, so that a very little swelling of the membrane is sufficient to close the orifice entirely.

Notice that the orifices of the frontal and ethmoid cells are so disposed that their secretion will pass away easily into the nose.

But this is not the case with the maxillary cells, to empty which the head must be inclined on one side. To see all these openings the respective turbinated bones must be raised.

c. The *inferior meatus* extends nearly along the whole length of the outer wall of the nose. By raising the lower turbinated bone, we observe, towards the front of the meatus, the termination of the nasal duct, through which the tears pass down from the lachrymal sac into the nose. This sac and duct can now be conveniently examined.

LACHRYMAL SAC AND NASAL DUCT. The lachrymal sac and nasal duct constitute the passage through which the tears are conveyed from the lachrymal ducts into the nose (p. 81). The lachrymal sac occupies the groove on the nasal side of the orbit. The upper end is round and closed; the lower gradually contracts into the nasal duct, and opens into the inferior meatus. The sac is composed of a strong fibrous and elastic tissue, which adheres very closely to the bone, and is lined by mucous membrane. Its front surface is covered by the tendo oculi and the fascia proceeding from it.

The nasal duct is from half to three-quarters of an inch in length, and is directed downwards, backwards, and a little outwards. Its termination is guarded by a valvular fold of mucous membrane; consequently, when air is blown into the nasal passages while the nostrils are closed, the lachrymal sac does not become distended. The lachrymal sac and the nasal duct are lined with ciliated epithelium, and the canaliculi with the squamous variety.

Behind the inferior turbinated bone is the opening of the Eustachian tube (p. 186). Into this, as well as into the nasal duct, we ought to practise the introduction of a probe. The chief difficulty is to prevent the probe from slipping into the cul-de-sac between the tube and the back of the pharynx.

MUCOUS OR SCHNEIDERIAN MEMBRANE.* This membrane lines the cavities of the nose and the air-cells communicating with it, and adheres very firmly to the periosteum. Its con-

* Schneider, 'De catarrhis.' Wittenberg, 1660.

tinuity may be traced into the pharynx, into the various sinuses, into the orbits through the nasal ducts, and into the tympana and mastoid cells through the Eustachian tubes. At the lower border of the turbinated bones it is disposed in thick and loose folds. The membrane varies in thickness and vascularity in different parts of the nasal cavities. Upon the lower half of the septum and the inferior turbinated bones, it is much thicker than elsewhere, owing to a fine plexus of arteries and veins in the submucous tissue. In the sinuses the mucous membrane is thinner, less vascular, and closely adherent to the periosteum.

The great vascularity of the mucous membrane raises the temperature of the inspired air, and pours out a copious secretion which prevents the membrane from becoming too dry.

The mucous membrane of the nasal cavities is not lined throughout by the same kind of epithelium. Near the nostrils the mucous membrane is furnished with papillæ, with a squamous epithelium like the skin, and a few small hairs (*vibrissæ*). In the lower part of the nose—namely, along the respiratory tract and in the sinuses—the epithelium is columnar and ciliated; but in the true olfactory region—that is, upon the superior and middle turbinated bones and the upper half of the septum—the epithelium is columnar, but not ciliated. In this region the mucous membrane is extremely vascular, thick, and studded with simple mucous glands. The columnar epithelial cells taper off at their deep ends into fine processes. Lying between these processes are fusiform cells, with central well-defined nuclei, to which the name of *olfactory cells* has been given; and it is probable that the attenuated processes which pass inwards from these cells are in direct connection with the terminal fibrils of the olfactory nerves.

The *arteries* of the nasal cavities are derived from the anterior and posterior ethmoidal branches of the opththalmic, and from the nasal branch of the internal maxillary, which enters the nose through the spheno-palatine foramen. The external nose is supplied by the nasal branch of the ophthalmic (p. 215), the arteria lateralis nasi, the angular, and the artery of the septum.

The *veins* of the nose correspond with the arteries. They communicate with the veins within the cranium through the foramina in the cribriform plate of the ethmoid bone; also through the ophthalmic vein and the cavernous sinus. These communications explain the relief frequently afforded by hæmorrhage from the nose in cases of cerebral congestion.

The mucous membrane of the nose is supplied with sensory nerves by the fifth pair. Thus, its *roof* is supplied with filaments from the external branch of the nasal nerve, and from the Vidian; its *outer wall*, by filaments from the superior nasal branches of the spheno-palatine ganglion, from the nasal, from the inner branch of the anterior dental, and from the inferior nasal branches of the large palatine nerve; its *septum*, by the septal branch of the nasal nerve, by the nasal branches of the spheno-palatine ganglion, by the naso-palatine, and by the Vidian; its *floor*, by the naso-palatine, and the inferior nasal branches of the large palatine nerve.

OLFACTORY NERVES. The olfactory nerves, proceeding from each olfactory bulb, in number about twenty on each side, pass through the foramina in the cribriform plate of the ethmoid bone. In its passage each nerve is invested with a coat derived from the dura mater. They are arranged into an inner, a middle, and an outer set. The *inner*, which are the largest, traverse the grooves in the upper third of the septum. The *middle* ramify on the roof of the nose. The *outer* pass through grooves in the upper and middle turbinated bones and the os planum of the ethmoid.

The nerves descend between the mucous membrane and the periosteum, and break up into filaments which communicate freely with one another, and form minute plexuses with small elongated intervals. Microscopically, the filaments differ from the other cerebral nerves, in containing no white substance of Schwann, and in being pale, finely granular, and nucleated.

DISSECTION OF THE MUSCLES OF THE BACK.

Those muscles of the back—namely, the trapezius, latissimus dorsi, levator anguli scapulæ, and rhomboidei—which are concerned in the movements of the upper extremity, will be examined in the dissection of the arm. These, therefore, having been removed, we proceed to examine two muscles, named, from their appearance, *serrati*, which extend from the spine to the ribs.

SERRATUS POSTICUS SUPERIOR. This muscle is situated beneath the rhomboidei. It is a thin flat muscle and *arises* from the lower part of the ligamentum nuchæ,* from the spines of the last cervical, and two or three upper dorsal vertebræ, by a sheet-like aponeurosis which makes up nearly half the muscle: the fibres run obliquely downwards and outwards, and are *inserted* by four fleshy slips into the second, third, fourth, and fifth ribs beyond their angles. Its *action* is to raise these ribs, and therefore to assist in inspiration.

SERRATUS POSTICUS INFERIOR. This muscle is situated beneath the latissimus dorsi. It *arises* from the spines of the two last dorsal and two upper lumbar vertebræ by means of the *lumbar aponeurosis.* It ascends obliquely outwards, and is *inserted* by four fleshy slips into the four lower ribs, external to their angles. Its *action* is to pull down these ribs, and therefore to assist in expiration The posterior serrati muscles are supplied by the posterior divisions of the spinal nerves.

VERTEBRAL APONEUROSIS. The thin aponeurosis which separates the muscles of the upper extremity from those of the back is called *vertebral aponeurosis.* Superiorly, it is continued beneath the serratus posticus superior; inferiorly, it binds down the muscles contained in the vertebral groove, by stretching

* The ligamentum nuchæ is a rudiment of the great elastic ligament of quadrupeds (termed the *pack wax*) which supports the weight of the head. It proceeds from the spine of the occiput to the spines of all the cervical vertebræ except the atlas; otherwise it would interfere with the free rotation of the head.

across from the spinous processes to the angles of the ribs: it is also connected below with the aponeurosis of the latissimus dorsi and the serratus inferior.

LUMBAR FASCIA. This aponeurosis consists of three layers, of which only the posterior layer can now be seen; the other two being demonstrated in the dissection of the abdominal muscles. The posterior or superficial layer is attached to the crest of the ilium, to the spinous processes of all the lower dorsal, lumbar, and sacral vertebræ; it forms a sheath for the erector spinæ, and serves for the attachment of the latissimus dorsi, and the serratus posticus inferior.

The serratus posticus superior must now be reflected from its origin, and turned outwards to expose the following muscle.

SPLENIUS. This *arises* from the spines of the five or six upper dorsal and the last cervical vertebræ, and from the lower half of the ligamentum nuchæ. The fibres ascend and divide into two portions, named, according to their respective insertions, *splenius capitis* and *splenius colli.*

a. The *splenius capitis* is inserted into the mastoid process, and into the outer part of the superior curved line of the occipital bone, beneath the sterno-mastoid.

b. The *splenius colli* is inserted by tendinous slips into the posterior tubercles of the transverse processes of the upper three cervical vertebræ. The splenius is supplied by the posterior divisions of the spinal nerves.

The *action* of the splenius, taken as a whole, is to draw the head and the upper cervical vertebræ towards its own side: so far, it co-operates with the opposite sterno-mastoid muscle. When the splenii of opposite sides contract, they extend the cervical portion of the spine, and keep the head erect. The permanent contraction of a single splenius may occasion wry neck. It is necessary to be aware of this, otherwise one might suppose the opposite sterno-mastoid to be affected, considering that the appearance of the distortion is alike in either case.

DISSECTION. The splenius and serratus posticus inferior are to be detached from their origins. After reflect-

ing the lumbar fascia from its internal attachment, the erector spinæ is exposed.

ERECTOR SPINÆ. The mass of muscle which occupies the vertebral groove on either side of the spine, is, collectively, called *erector spinæ*, since it counteracts the tendency of the trunk to fall forwards. Observe that it is thickest and strongest at that part of the spine where it has the greatest weight to support—namely, in the lumbar region; and that its thickness gradually decreases towards the top of the spine.

It *arises* by tendinous fibres from the posterior fifth of the crest of the ilium, the lower part and back of the sacrum, and the spines of the lumbar vertebræ. From this extensive origin the muscular fibres ascend, at first as a single mass. Near the last rib, this mass divides into two; an outer, called the *sacro-lumbalis*; an inner, the *longissimus dorsi*. These two portions should be followed up the back: and there is no difficulty in doing so, because the division is indicated by a longitudinal groove, in which we observe the cutaneous branches of the intercostal vessels and nerves.

SACRO-LUMBALIS. Tracing the *sacro-lumbalis* upwards, we find that it terminates in a series of tendons which are *inserted* into the angles of the six lower ribs.

MUSCULUS ACCESSORIUS. By turning outwards the sacro-lumbalis, we observe that it is continued upwards under the name of *musculus accessorius ad sacro-lumbalem*. This *arises* by a series of tendons from the angles of the seven or eight lower ribs, internal to the preceding, and is *inserted* into the angles of the five or six upper ribs.

CERVICALIS ASCENDENS. This is the cervical continuation of the musculus accessorius. It *arises* by tendinous slips from the four or five upper ribs, and is inserted into the transverse processes of the fourth, fifth and sixth cervical vertebræ.

LONGISSIMUS DORSI. The longissimus dorsi (the inner portion of the erector spinæ) terminates in tendons which are *inserted*, internally, into the tubercles * at the root of the transverse

* Called 'anapophyses' by Professor Owen.

processes of the lumbar vertebræ, also into the transverse processes of all the dorsal vertebræ, and, externally, into the greater number of the ribs (varying from eight to eleven) between their tubercles and angles, and, lower down, into the lumbar fascia, and into the transverse processes of the lumbar vertebræ.

TRANSVERSALIS COLLI. This is the cervical continuation of the longissimus dorsi. It *arises* by tendinous slips from the transverse processes of the second, third, fourth, fifth, and sixth dorsal vertebræ, and is inserted into the posterior tubercles of the transverse processes of the four or five lower cervical vertebræ except the last.

TRACHELO-MASTOID. This muscle, situated on the inner side of the preceding, is the internal continuation of the longissimus dorsi to the cranium. It arises from the transverse processes of the three or four upper dorsal, and the articular processes of the three or four lower cervical vertebræ, and is inserted by a flat tendon into the back part of the mastoid process beneath the splenius.*

* Those who are familiar with the transcendental nomenclature of the vertebrate skeleton will understand from the following quotation the plan upon which the muscles of the back are arranged :—

'The muscles of the back are either longitudinal or oblique : that is, they either pass vertically downwards from spinous process to spinous process, from diapophysis to diapophysis, from rib to rib (pleurapophyses), &c., or they extend obliquely from diapophysis to spine, or from diapophysis to pleurapophysis, &c.

'The erector spinæ is composed of two planes of longitudinal fibres aggregated together, below, to form one mass at their point of origin, from the spines and posterior surface of the sacrum, from the sacro-iliac ligament, and from the posterior third of the iliac crest. It divides into two portions, the sacro-lumbalis and the longissimus dorsi.

'The former, arising from the iliac crest, or from the pleurapophysis (rib) of the first sacral vertebra, is inserted by short flat tendons into (1) the apices of the stunted lumbar ribs, close to the tendinous origins of the transversalis abdominis ; (2) the angles of the eight or nine inferior dorsal ribs ; (3) it is inserted, through the medium of the musculus accessorius, into the angles of the remaining superior ribs, and into the long and occasionally distinct pleurapophysial element of the seventh cervical vertebra ; and (4) through the medium of the cervicalis ascendens, into the pleurapophysial elements of the third, fourth, fifth, and sixth cervical vertebræ. In other words, the muscular fibres extend from rib to rib, from the sacrum to the third cervical vertebra.

SPINALIS DORSI. This is a long narrow muscle, situated close to the spines of the dorsal vertebræ, and apparently a part of the longissimus dorsi; it is by some considered the innermost column of the erector spinæ. It *arises* by tendinous slips from the spines of the two lower dorsal and two upper lumbar vertebræ, and is *inserted* by little tendons into the spines of the six or eight upper dorsal vertebræ.

The muscles of the spine hitherto examined are all longitudinal in their direction. We now come to a series which run obliquely from the transverse to the spinous processes of the vertebræ. And first of the complexus.

COMPLEXUS. This powerful muscle *arises* from the transverse processes of the six or seven upper dorsal and the last cervical vertebræ, also from the articular processes of four or five cervical vertebræ. It is *inserted* between the two curved lines of the occiput, near the vertical crest. In the centre of the muscle there is generally a tendinous intersection. The muscle is perforated by the posterior branches of the second (the great occipital), third, and fourth cervical nerves. It is chiefly supplied by the great occipital nerve. Its *action* is to maintain the head erect.

Cut transversely through the middle of the complexus, and reflect it to see the arteria cervicalis profunda (p. 69), and the posterior branches of the cervical nerves.

TRANSVERSO-SPINALIS. This is the mass of muscle which lies in the vertebral groove after the reflection of the complexus and the erector spinæ. It consists of a series of fibres which extend from the transverse and articular processes to the

'The longissimus dorsi, situated nearer the spine than the sacro-lumbalis, is inserted (1) into the metapophysial spine of the lumbar diapophyses; (2) into the diapophyses of all the dorsal vertebræ, near the origin of the levatores costarum; (3) through the medium of the transversalis colli into the diapophyses of the second, third, fourth, fifth, and sixth cervical vertebræ; and (4) through the medium of the trachelo-mastoid into the mastoid process, or the only element of a transverse process possessed by the parietal vertebra. In other words, its fibres extend from diapophysis to diapophysis, from the sacrum, upwards, to the parietal vertebra.'—'Homologies of the Human Skeleton,' by H. Coote, p. 75.

spinous processes of the dorsal and cervical vertebræ, and is for convenience divided into the *semispinalis dorsi* and *semispinalis colli.*

a. The *semispinalis dorsi arises* from the transverse processes of the dorsal vertebræ, from the sixth to the tenth, and is *inserted* into the spines of the four upper dorsal and the two or three lower cervical vertebræ.

b. The *semispinalis colli* lies beneath the complexus and *arises* from the transverse processes of the five or six upper dorsal vertebræ, and the articular processes of the four lower cervical, and is *inserted* into the spines of the axis and the three or four succeeding vertebræ, that into the axis being the most fleshy fasciculus.

Now reflect part of the semispinalis dorsi in order to expose the *multifidus spinæ.* This may be considered a part of the preceding muscle, since its fixed points and the direction of its fibres are the same. It consists of a series of little muscles which extend between the spines and transverse processes of the vertebræ from the sacrum to the second cervical vertebra. Those in the lumbar region are the largest. They *arise* by tendinous slips from the transverse processes in the sacral and dorsal region, and from the articular processes in the lumbar and cervical region. They all ascend obliquely, and are *inserted* into the spines and laminæ of all the vertebræ excepting the atlas. It should be observed that their fibres are not of uniform length; some extend only from vertebra to vertebra, while others extend between one, two, or even three vertebræ.

Beneath the multifidus spinæ, in the dorsal region of the spine only, are eleven flat muscles, called *rotatores spinæ.* They *arise* from the upper part of the transverse processes, and are *inserted* into the lower border of the laminæ of the vertebra above. These muscles form but a part of the multifidus spinæ.

The action of the preceding muscles is, not only to assist in maintaining the trunk erect, but to incline and rotate the spine to one or the other side. They are all supplied by the posterior branches of the spinal nerves.

LEVATORES COSTARUM. These small muscles *arise* from the apices of the transverse processes of the seventh cervical and the eleven upper dorsal vertebræ, and are *inserted* into the rib below. The direction of their fibres corresponds with that of the outer layer of the intercostal muscles. They are muscles of inspiration.

INTERSPINALES. These muscles extend between the spines of contiguous vertebræ. They are arranged in pairs, and only exist in those parts of the vertebral column which are the most movable. In the cervical region they pass between the spines of the six lower cervical vertebræ. In the dorsal they are found between the spines of the first and second, and between those of the eleventh and twelfth dorsal vertebræ. They are also found more or less distinctly between the spines of the lumbar vertebræ.

INTERTRANSVERSALES. These muscles extend between the transverse processes in the cervical and lumbar regions. In the neck they are arranged in pairs, like the interspinales, and the corresponding cervical nerve separates one from the other. In the lumbar region they are four in number, and are arranged also in pairs.

We have next to examine the muscles concerned in the movements of the head upon the first and second cervical vertebræ. (Fig. 47.)

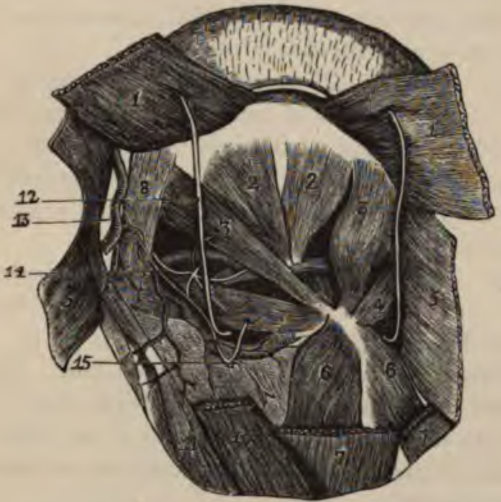
RECTUS CAPITIS POSTICUS MAJOR. This is a largely developed interspinal muscle. It *arises* by a small tendon from the well-marked spine of the second cervical vertebra, and, expanding considerably, is *inserted* below the superior curved ridge of the occipital bone. These recti muscles, as they ascend, one on each side, to their insertions, diverge and leave an interval between them in which are found the recti capitis postici minores.

RECTUS CAPITIS POSTICUS MINOR. This is also an interspinal muscle, but smaller than the preceding. *Arising* from the posterior tubercle of the first vertebra, it expands as it ascends, and is *inserted* into the occipital bone between the inferior curved ridge and the foramen magnum. The *action* of the two preceding

muscles is to raise the head. They are supplied with nerves from the posterior branch of the sub-occipital.

OBLIQUUS INFERIOR. This *arises* from the spine of the second cervical vertebra, and is *inserted* into the transverse process of the first. Its *action* is to rotate the first upon the second vertebra: in other words, to turn the head round to the same side. It is supplied with a nerve by the great occipital

FIG. 47.



DRAWING FROM NATURE OF THE SUBOCCIPITAL TRIANGLE.

1 and 7. Complexus. 2. Rectus cap. posticus minor. 3. Rectus cap. posticus major. 4. Obliquus inferior. 5. Sterno-mastoid. 6. Semispinalis colli. 8. Obliquus superior. 10. Splenius. 11. Trachelo-mastoid. 12. Great occipital nerve. 13. Occipital artery giving off its descending branch—the *princeps cervicis*. 14. Suboccipital nerve. 15. Third cervical nerve (posterior branch).

(posterior division of the second cervical) which curves up under its lower border.

OBLIQUUS SUPERIOR. This muscle *arises* from the transverse process of the atlas, and, ascending obliquely inwards, is *inserted* in the interval between the curved ridges of the occipital bone. Its *action* is to draw the occiput towards the spine.

SUBOCCIPITAL TRIANGLE. Observe that the obliqui (superior and inferior) and the rectus capitis posticus major form what is called the *suboccipital triangle.* The outer side is formed by the obliquus superior; the inner, by the rectus capitis posticus major; the lower, by the obliquus inferior. Within this triangle may be seen the arch of the atlas, and the vertebral artery lying in a groove on its upper surface. Between the artery and the bone appears the posterior division of the suboccipital nerve, which here sends branches to the recti postici, the obliqui, and the complexus: that is to say, it supplies the muscles which form the triangle, and the complexus that covers it.

RECTUS CAPITIS LATERALIS. This small muscle extends between the transverse process of the first vertebra and the eminentia jugularis of the occiput; but, since this eminence is the transverse process of the occipital vertebra, the muscle should be considered as an intertransverse one. Its nerve comes from the anterior division of the sub-occipital.

NERVES OF THE BACK. The posterior branches of the spinal nerves supply the muscles and skin of the back. They pass backwards between the transverse processes of the vertebræ, and divide into *external* and *internal* branches. The general plan upon which these nerves are arranged is the same throughout the whole length of the spine; but since there are certain peculiarities deserving of notice in particular situations, we must examine each region separately.

CERVICAL REGION. The posterior division of the first cervical nerve (the suboccipital) passes between the arch of the atlas and the vertebral artery, and divides into branches which supply the recti and obliqui muscles concerned in the movement of the head. It also sends downwards a loop to communicate with the second cervical nerve. It sometimes gives off a cutaneous branch which accompanies the occipital artery, and is distributed to the skin of the back of the scalp.

The posterior branch (the great occipital) of the second cervical nerve is the largest of the series, and emerges between the arches of the atlas and axis. It turns upwards beneath the inferior

oblique muscle, passes through the complexus, and runs with the occipital artery to the back of the scalp.

The posterior divisions of the six lower cervical nerves divide into *external* and *internal* branches. The *external* are small, and terminate in the splenius, and the continuation of the erector spinæ—viz., the trachelo-mastoid, the transversalis colli, and the cervicalis ascendens. The *internal*, by far the larger, proceed towards the spines of the vertebræ; those of the third, fourth, and fifth lie between the complexus and the semispinalis,* and after supplying the muscles terminate in the skin; those of the sixth, seventh, and eighth lie between the semispinalis and the multifidus spinæ, to which they are distributed.

DORSAL REGION. The posterior divisions of the spinal nerves in this region come out between the transverse processes and the tendons attached to them. They soon divide into *external* and *internal* branches. The *external* pass obliquely over the levatores costarum, between the sacro-lumbalis and the longissimus dorsi; and successively increase in size from above downwards. The upper six terminate in the erector spinæ and the levatores costarum; the rest, after supplying these muscles, pass through the latissimus dorsi, and become the cutaneous nerves of the back. The *internal* successively decrease in size from above downwards. They run towards the spine between the semispinalis dorsi and the multifidus spinæ. The upper six, after giving branches to the muscles, perforate the trapezius and become cutaneous nerves. The lower ones terminate in the muscles of the vertebral groove.

LUMBAR REGION. The general arrangement of the nerves in this region resembles that of the dorsal. Their *external* branches, after supplying the erector spinæ, become cutaneous and terminate in the skin over the buttock. The *internal* branches supply the multifidus spinæ.

SACRAL REGION. The posterior divisions of the spinal nerves in this region are small. With the exception of the

* The posterior branches of the second, third, and fourth nerves are generally connected, beneath the complexus, by branches in the form of loops. This constitutes the posterior cervical plexus of some anatomists.

last, they come out of the spinal canal through the foramina in the back of the sacrum. The upper two or three divide into *external* and *internal* branches. The *internal* terminate in the multifidus spinæ; the *external* become cutaneous and supply the skin of the gluteal region. The last two sacral nerves proceed, without dividing, to the integument.

The *coccygeal* nerve is exceedingly small, and, after joining a small branch from the last sacral, terminates in the skin.*

ARTERIES OF THE BACK. The arteries which supply the back are:—1. Small branches from the occipital; 2. Small branches from the vertebral; 3. The deep cervical; 4. The posterior branches of the intercostal and lumbar arteries.

The *occipital* artery furnishes several small branches to the muscles at the back of the neck; one, larger than the rest, the *arteria princeps cervicis*, descends beneath the complexus, and generally inosculates with the deep cervical artery, and with small branches from the vertebral.

The *vertebral artery* runs along the groove in the arch of the atlas, and, before perforating the posterior occipito-atlantoid ligament to enter the skull, distributes small branches to the adjacent muscles.

The *deep cervical* artery is the posterior branch of the first intercostal artery (from the subclavian). It passes backwards between the transverse process of the last cervical vertebra and the first rib: it then ascends between the complexus and the semispinalis colli, and anastomoses with the princeps cervicis.

The *posterior* branches of the intercostal and lumbar arteries accompany the corresponding nerves, and are in all respects similar to them in distribution. Each sends a small branch into the spinal canal (*intraspinal*), and small branches to the vertebra.

The *veins* correspond to the arteries.

PRÆ-VERTEBRAL MUSCLES. We have, lastly, to examine three muscles situated in front of the spine: namely, the longus colli, the rectus capitis anticus major, and the rectus capitis

* The branching of the posterior divisions of the several spinal nerves has been accurately described by Ellis, 'Med. Gazette,' Feb. 10, 1843.

anticus minor. In order to have a complete view of the two latter, a special dissection should be made, before the head is removed from the first vertebra.

LONGUS COLLI. This muscle is situated in front of the spine, and extends from the third dorsal to the first cervical vertebra. For convenience of description it is divided into three sets of fibres, of which one extends *longitudinally* from the body of one vertebra to that of another; the two others extend *obliquely* between the transverse processes and the bodies of the vertebræ.

The *longitudinal* portion of the muscle *arises* from the bodies of the two or three upper dorsal and the three lower cervical vertebræ, and is *inserted* into the bodies of the second, third and fourth cervical vertebræ.

The *superior oblique* portion, *arising* from the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ, ascends inwards, and is *inserted* into the front part or body of the first cervical vertebra. The *inferior oblique* portion proceeds from the bodies of the three upper dorsal vertebræ, and is *inserted* into the transverse processes of the fifth and sixth cervical vertebræ. The *action* of this muscle, taken as a whole, must be to bend the cervical region of the spine. Its nerves come from the cervical and brachial plexuses.

RECTUS CAPITIS ANTICUS MAJOR. This muscle *arises* from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and is *inserted* into the basilar process of the occipital bone, in front of the foramen magnum.

RECTUS CAPITIS ANTICUS MINOR. This muscle *arises* from the root of the transverse process of the first cervical vertebra, and is *inserted* into the basilar process of the occipital bone, nearer to the foramen magnum than the preceding muscle. The *action* of the recti muscles is to bend the head forwards. They are supplied with nerves from the anterior division of the sub-occipital.

LIGAMENTS OF THE SPINE.

The vertebræ are connected by their intervertebral fibro-cartilages, by ligaments in front of and behind their bodies, and by ligaments which extend between their arches and their spines. Their articular processes have capsular ligaments, and synovial membranes.

ANTERIOR COMMON LIGAMENT. This is a strong band of longitudinal fibres which extends along the front of the bodies of the vertebræ from the axis to the sacrum. The fibres are not all of equal length. The more superficial extend from one vertebra to the fourth or fifth below it; those a little deeper pass from one vertebra to the second or third below it; while the deepest of all preceed from vertebra to vertebra. The ligament becomes broader and stronger in proportion to the size of the vertebræ. By making transverse incisions through it in different situations, we observe that its fibres are more firmly adherent to the intervertebral cartilages, and to the borders of the vertebræ, than to the middle of the bones.

POSTERIOR COMMON LIGAMENT. This extends longitudinally, in a similar manner to the anterior common ligament, along the posterior surface of the bodies of the vertebræ, from the axis to the sacrum, and sends up a prolongation to the anterior border of the foramen magnum continuous with the apparatus ligamentosus.

INTERSPINOUS LIGAMENTS. These bands of ligamentous fibres fill up the intervals between the spines of the dorsal and lumbar vertebræ. They are the most marked in the lumbar region. Those fibres which connect the apices of the spines, being stronger than the rest, are described as separate ligaments under the name of *supra-spinous*. Their use is to limit the flexion of the spine.

LIGAMENTS BETWEEN THE ARCHES OF THE VERTEBRÆ. These are called, on account of their colour, *ligamenta subflava.*—To obtain a good view of them, the arches of the vertebræ should be removed with a saw. They pass between the

arches of the contiguous vertebræ, from the axis to the sacrum; none existing between the occiput and the atlas, or between the atlas and axis. They are composed of yellow elastic tissue, the fibres being arranged vertically, and their strength increases with the size of the vertebræ. This elasticity answers a double purpose: it not only permits the spine to bend forwards, but materially assists in restoring it to its *curve of rest*. They economise muscular force, like the ligamentum nuchæ in animals.

INTERVERTEBRAL FIBRO-CARTILAGE. This substance, placed between the bodies of the vertebræ, is by far the strongest bond of connection between them, and fulfils most important purposes in the mechanism of the spine. Its peculiar structure is adapted to break shocks, and to render the spine flexible and resilient. To see the structure of an intervertebral fibro-cartilage, a horizontal section must be made through it. It is firm and resisting near the circumference, but soft and pulpy towards the centre. The circumferential portion is composed of concentric layers of fibro-cartilage, placed vertically. These layers are attached by their edges to the vertebræ; they gradually decrease in number from the circumference towards the centre, and the interstices between them are filled by soft pulpy tissue. The central portion is composed almost entirely of this pulpy tissue; and it bulges when no longer under pressure. Thus the bodies of the vertebræ, in their motions upon each other, revolve upon an elastic cushion tightly girt all round by bands of fibrous tissue. These motions are regulated by the articular processes.

Dissect an intervertebral substance layer after layer in front, and you will find that the circumferential fibres extend *obliquely* between the vertebræ, crossing each other like the branches of the letter X.

The thickness of the intervertebral cartilages is not the same in front and behind. It is this difference in their thickness, more than that in the bodies of the vertebræ, which produces the several curves of the spine. In the lumbar and cervical regions they are thicker in front; in the dorsal region, behind.

The structure of the intervertebral cartilages explains the well-known

fact that a man becomes shorter after standing for some hours; and that he regains his usual height after rest. The difference between the morning and evening stature amounts to more than half an inch.

It also explains the fact that a permanent lateral curvature of the spine may be produced (especially in the young) by the habitual practice of leaning to this or that side. Experience proves that the cause of lateral curvature depends more frequently upon some alteration in the structure of the fibro-cartilages than upon the bones. From an examination of the bodies of one hundred and thirty-four individuals with crooked spines, it was concluded that, in two-thirds, the bones were perfectly healthy; that the most frequent cause of curvature resided in the invertebral substances, these being, on the concave side of the curve, almost absorbed, and, on the convex side, preternaturally developed. As might be expected in these cases, the muscles on the convex side become lengthened, and degenerate in structure.*

LIGAMENTUM NUCHÆ. This ligament is a thin fibrous septum intermingled with elastic tissue, which extends from the spinous processes of the six lower cervical vertebræ to the external occipital protuberance. It forms an intermuscular septum down the back of the neck, and may be regarded as the continuation upwards of the supra-spinous ligament.

CAPSULAR LIGAMENTS. Each joint between the articular processes has a capsular ligament and a synovial membrane. The surfaces of the bones are crusted with cartilage.

INTERTRANSVERSE LIGAMENTS. These are thin bands of fibres which pass between the transverse processes of the vertebræ. They are rudimentary in the cervical region, and are sometimes absent.

MOVEMENTS OF THE SPINE. Though but little movement is permitted between any two vertebræ (the atlas and axis excepted), yet the collective motion between them all is considerable. The spine can be bent forwards, backwards, or on either side; it also admits of slight rotation. In consequence of the elasticity of the intervertebral cartilages and the ligamenta subflava, it returns spontaneously to its natural curve of rest like an elastic bow. Its mobility is greatest in the cervical region, on account of

* On this subject see 'Hildebrandt's Anatomie,' B. ii. s. 155.

the thickness of the fibro-cartilages, the small size of the vertebræ, the oblique direction of their articulations, and, above all, the horizontal position and the shortness of their spines. In the dorsal region there is very little mobility, on account of the vertical direction of the articular processes, and the manner in which the arches and the spines overlap each other. In the lumbar region, the spine again becomes more movable, on account of the thickness of the intervertebral cartilages, and the horizontal direction of the spinous processes.

Ligaments between the Occipital Bone and the Atlas. The occiput is connected to the atlas by an *anterior occipito-atlantoid* ligament which passes from the foramen magnum to the front arch of the atlas. The thickest part of this is in the middle. A *posterior occipito-atlantoid* ligament extends in a similar manner from the posterior border of the foramen magnum to the posterior arch of the atlas. It is thin and, superiorly, becomes blended with the dura mater, and is pierced by the vertebral artery and the suboccipital nerve. Between the condyles of the occipital bone and the atlas, there is on each side a capsular ligament.

The movements which take place between the occipital bone and the atlas are flexion and extension, as in nodding forwards and backwards; and lateral movement, as in inclining the head sideways.

Ligaments between the Occipital Bone and the Axis. These are the most important; and to see them, the spinal canal must be exposed by removing the arches of the upper cervical vertebræ, and the posterior common ligament, which is here very thick and strong. It descends from the basilar process of the occipital bone over the odontoid and transverse ligaments, and is called the *occipito-axoid ligament* or the *apparatus ligamentosus colli.*

Odontoid or Check Ligaments. The odontoid or check ligaments (fig. 48) are two very strong ligaments which proceed from the sides of the odontoid process to the tubercles on the inner sides of the condyles of the occiput. Their use is to limit the

rotation of the head. A third or middle odontoid ligament passes from the apex of the odontoid process to the margin of the foramen magnum. It is sometimes called the *ligamentum suspensorium.*

ARTICULATION BETWEEN THE ATLAS AND THE AXIS.

The odontoid process of the axis forms a pivot upon which the head and atlas rotate. The most important ligament is the *transverse* (fig. 48). It passes behind the odontoid process, and is attached to the tubercles on the inner sides of the articular processes of the

FIG. 48.

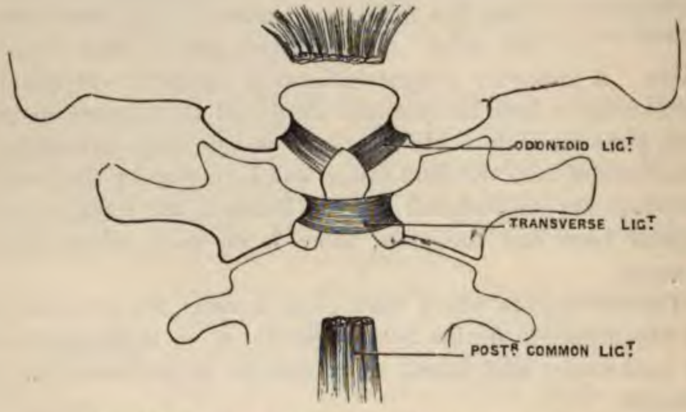


DIAGRAM OF THE ODONTOID AND TRANSVERSE LIGAMENTS.

atlas. From the centre of this ligament a few fibres pass upwards, to be attached to the basilar process, and some downwards to the body of the axis, giving it a cruciform appearance. Thus it forms with the atlas a ring, into which the odontoid process is received. If this transverse ligament be divided, we observe that the odontoid process is covered with cartilage in front and behind, and is provided with two synovial membranes.

The anterior arch of the atlas is connected to the body of the axis by the *anterior atlanto-axoid* ligament; posteriorly, the two arches are connected by the *posterior atlanto-axoid* ligament.

ARTICULATION OF THE RIBS. All the ribs, with the exception of the first and the two last, are articulated with the bodies of two vertebræ, and with the transverse processes (fig. 49).

The head of each rib presents two articular surfaces, corresponding to the bodies of two vertebræ. There are two distinct articulations, each provided with a separate synovial membrane. The ligaments are:—1. An *anterior*, which connects the head of the rib with the vertebræ, and with the intervening fibro-cartilage: this, on account of the divergence of its fibres, is called the stellate ligament (fig. 50). 2. An *inter-articular*, which proceeds from the head of the rib to the intervertebral cartilage.

FIG. 49.

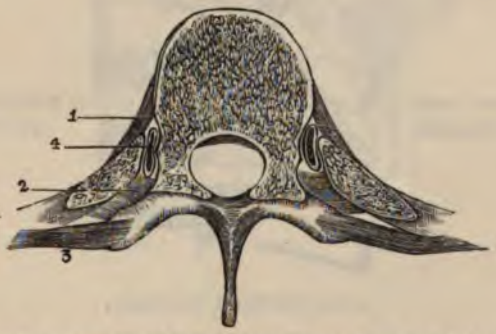


DIAGRAM SHOWING THE LIGAMENTS CONNECTING THE RIB WITH THE VERTEBRA.

1. The anterior costo-central ligament.
2. The interosseous, or middle costo-transverse ligament.
3. The posterior costo-transverse ligament.
4. The synovial membrane between the rib and the body of the vertebra.

The tubercle of the rib articulates with the transverse process. This articulation has a capsular and synovial membrane, and is secured by the following ligaments:—1. The *posterior costo-transverse* passes from the apex of the transverse process to the summit of the tubercle of the rib. 2. The *middle costo-transverse* connects the neck of the rib to the front surface of the transverse process. 3. The *superior costo-transverse* ascends from the neck of the rib to the lower border of the transverse process above it (fig. 50).

The head of the first rib articulates with a single vertebra.

The eleventh and twelfth ribs articulate each with a single vertebra, and are not connected to the transverse processes.

CONNECTION BETWEEN THE CARTILAGES OF THE RIBS AND THE STERNUM.

The cartilages of all the true ribs are received into slight concavities on the side of the sternum, and are secured by anterior, posterior, upper and lower ligaments. There is a synovial membrane between the cartilage of each rib and the sternum, except that of the first, and usually at each articulation the synovial membrane is separated into two by an inter-articular ligament.

FIG. 50.

1. 1. 1. Superior costo-transverse ligaments.

2. 2. 2. Anterior costo-central or stellate ligaments.

COSTO-VERTEBRAL LIGAMENTS.

The *costal cartilages from the sixth to the tenth* are connected by ligamentous fibres.

ARTICULATION OF THE LOWER JAW.

The condyle of the lower jaw articulates with the glenoid cavity of the temporal bone. The joint is provided with an inter-articular fibro-cartilage, with external and internal lateral ligaments, and two synovial membranes (fig. 51).

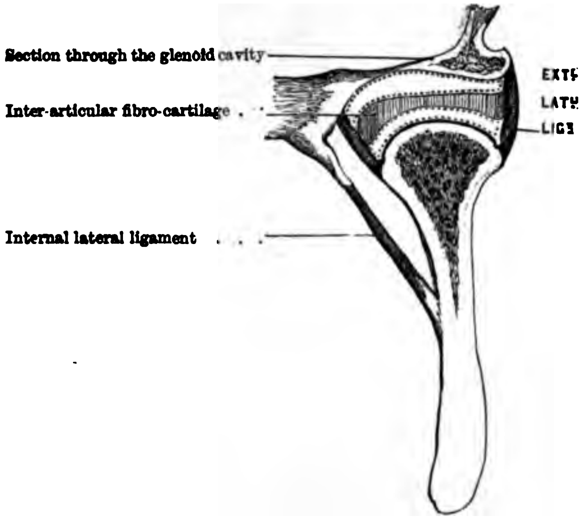
The *external lateral ligament* extends from the zygoma and its tubercle; its fibres pass downwards and backwards to the tubercle of the condyle of the jaw.

The *internal lateral ligament* extends from the spinous process of the sphenoid bone to the border of the dental foramen. This so-called ligament cannot in any way contribute to the strength of

the joint: the articulation of one side performs the office of internal lateral ligament to the other.

The *inter-articular fibro-cartilage* is a thin plate of an oval form, and thicker at the margin than at the centre. It is connected on the outer side to the external lateral ligament, and on the inner side some of the fibres of the external pterygoid muscle are inserted into it.

FIG. 51.



TRANSVERSE SECTION TO SHOW THE LIGAMENTS AND THE FIBRO-CARTILAGE OF THE JOINT OF THE LOWER JAW. THE DOTTED LINES REPRESENT THE TWO SYNOVIAL MEMBRANES.

There are two *synovial membranes*, an upper and a lower, for the joint. The larger and looser of the two is situated between the glenoid cavity and the fibro-cartilage. The lower is interposed between the fibro-cartilage and the condyle of the jaw. They sometimes communicate through a small aperture in the centre of the fibro-cartilage.

The form of the articulation of the lower jaw admits of movement, upwards and downwards, forwards, backwards, and from side

to side. A combination of these movements takes place in mastication: during this act the condyles of the jaw describe an oblique rotatory movement in the glenoid cavity. The purposes served by the fibro-cartilage in this joint are:—first, it follows the condyle, and interposes a convenient socket for all its movements: second, being elastic, it breaks shocks; for shocks here would be almost fatal, considering what a thin plate of bone the glenoid cavity is, and that just above it is the brain.

DISSECTION OF THE UPPER EXTREMITY.

DISSECTION. THE arm being placed at right angles with the trunk, and slightly rotated outwards, make three incisions through the skin: the first, along the middle of the sternum; the second, along the lower border of the clavicle and down the front of the upper arm for about four inches; the third, from the ensiform cartilage, backwards, to the posterior border of the axilla.

The skin should be carefully dissected from the subjacent layer of subcutaneous fascia and fat. In doing so notice the thin fibres of the broad subcutaneous muscle of the neck, '*platysma myoides*' (p. 17).

CUTANEOUS NERVES. The numerous nerves which run through the subcutaneous tissue to the skin and mammary gland must be carefully dissected out. They are derived from various sources: some, branches of the superficial cervical plexus, descend over the clavicle; others, branches of the intercostal nerves, come through the intercostal spaces close to the sternum, each with a small artery; a third series, also branches of the intercostal nerves, come out on the side of the chest, and run forwards over the outer border of the pectoralis major.

The *supra-clavicular* nerves, which descend over the clavicle, are subdivided, according to their direction, into *sternal*, *clavicular*, and *acromial* branches (diagram, p. 19). The *sternal* cross the inner end of the clavicle to supply the skin over the upper part of the sternum. The *clavicular* pass over the middle of the clavicle, and supply the integument over the front of the chest and the mammary gland. The *acromial* branches cross over the outer end of the clavicle, and distribute their filaments to the skin of the shoulder.

Near the sternum are found the *anterior cutaneous branches* or terminal filaments of the *intercostal nerves*. After piercing the pectoralis major, each nerve sends an inner filament to the skin over the sternum, and an outer larger one, which supplies the skin over the pectoral muscle. That of the 3d and 4th intercostal supplies also the mammary gland.

Branches of the internal mammary artery, for the supply of the mammary gland, accompany these nerves. During lactation they increase in size, ramifying tortuously over the surface of the gland. They are occasionally as large as the radial at the wrist.

The *lateral cutaneous branches of the intercostal nerves* come out between the digitations of the serratus magnus on the side of the chest, and divide into anterior and posterior branches. The *anterior* branches curve round the free border of the pectoralis major and then supply the skin over that muscle and the mamma. The *posterior* branches supply the skin of the back of the chest.

DISSECTION. Dissect off the superficial fascia and fat with the mammary gland. Thus you will expose the strong *deep fascia* which is closely attached to the pectoralis major and deltoid muscles. It is continuous, above, with the fascia of the neck; below, with that of the arm. At the axilla it becomes denser, where it passes from the pectoral to the latissimus dorsi muscles.

Reflect this fascia from the pectoralis major by dissecting parallel with the course of its fibres. The muscle having been fully exposed, observe its shape, the course of its fibres, their origin and insertion.*

PECTORALIS MAJOR. The pectoralis major is the large triangular muscle in the front of the chest. It *arises* from the sternal half of the clavicle, from the front of the sternum, from the cartilages of all the true ribs except the first and the last,

* Sometimes we find a thin little muscle running perpendicularly in front of the inner part of the pectoralis major. This is the *rectus sternalis* or *sternalis brutorum*. It arises inferiorly by a tendinous expansion from the rectus abdominis, and is connected above to the tendon of the sterno-mastoid.

and from the aponeurosis of the external oblique muscle of the abdomen. The fibres converge towards the arm, and terminate in a flat tendon, about two inches in breadth, which is *inserted* into the anterior margin of the bicipital groove of the humerus. The arrangement of its fibres, as well as the structure of its tendon, is peculiar. The lower fibres, which form the boundary of the axilla, are folded beneath the rest, and terminate upon the upper part of the tendon—*i.e.* nearer to the shoulder joint; the upper fibres, which arise from the clavicle, and are frequently separated from the main body of the muscle by a slight interval, descend in front of the lower, and terminate upon the lower part of the tendon. Consequently the upper and lower fibres of the muscle cross each other previously to their insertion.

The object of this arrangement is to enable all the fibres to act simultaneously when the arm is extended.

The upper part of the tendon sends off a fibrous prolongation, which binds down the long head of the biceps, and is attached to the great tuberosity of the humerus: another tendinous expansion is prolonged backwards to the tendon of the deltoid muscle; and a third passes downwards to be intimately connected with the fascia of the upper arm.

The chief *action* of the pectoralis major is to draw the humerus towards the chest: as in placing the hand on the opposite shoulder, or in pulling an object towards the body. When the arm is raised and made the fixed point, the muscle assists in raising the trunk, as in climbing. Thus too, on emergency, it can act as an auxiliary muscle of inspiration.

Between the pectoralis major and the deltoid, the great muscle covering the shoulder, is an interval varying in extent in different subjects, but always more marked towards the clavicle. It contains a small artery—the *thoracica humeraria*—and the *cephalic vein*, which ascends on the outer side of the arm, and empties itself into the axillary. This interval is the proper place to feel for the coracoid process. In doubtful injuries about the shoulder, this point of bone is a good landmark in helping the surgeon to arrive at a correct diagnosis.

The pectoralis major is supplied with nerves by the anterior thoracic branches of the brachial plexus; with blood, by the long and short thoracic branches of the axillary artery.

DISSECTION. ANATOMY OF THE INFRA-CLAVICULAR REGION.

Reflect the clavicular part of the pectoralis major, and in doing so, notice a small nerve, the external anterior thoracic, which enters the under surface of this part of the muscle. Beneath the portion thus reflected, part of the pectoralis minor will be exposed. In this triangle, bounded, above, by the clavicle, below, by the upper border of the sternal origin of the pectoralis major, and, on the outer side, by the deltoid, is an important space in which the relative position of the following objects must be carefully examined:—

COSTO-CORACOID MEMBRANE.

a. A strong ligamentous expansion, called the costo-coracoid membrane extends from the cartilage of the first rib to the coracoid process. Between these points it is attached to the clavicle, and forms a complete investment for the subclavius muscle. Its crescent-shaped edge arches over, and protects the axillary vessels and nerves; from this edge is prolonged a funnel-shaped fascia, which covers the axillary vessels, forming the anterior portion of their sheath; the posterior being formed by a prolongation of the deep cervical fascia. The front portion of this sheath is perforated by the cephalic vein, the thoracica acromialis artery, and the anterior thoracic nerves. This fascia must be removed.

b. The subclavius muscle enclosed in its fibrous sheath.

c. The axillary vein, artery, and brachial plexus of nerves.

d. A short arterial trunk, the thoracic axis, which divides into several radiating branches.

e. The termination of the cephalic vein in the axillary.

f. Two nerves, the anterior thoracic, which descend from the brachial plexus below the clavicle, and cross in front of the axillary vessels to supply the pectoral muscles.

SUBCLAVIUS.

This muscle lies between the clavicle and the first rib. It *arises* from the first rib by a short round tendon at the junction of the bone and cartilage, and is

inserted into a groove on the under surface of the clavicle. Its nerve comes from the fifth and sixth cervical nerves. Its *action* is to depress the clavicle, and prevent its too great elevation.

RELATIVE POSITION OF THE AXILLARY VESSELS AND NERVES.

In the infra-clavicular space before us are the great vessels and nerves of the axilla in the first part of their course. They lie at a great depth from the surface. They are surrounded by a sheath of fascia, which descends with them beneath the clavicle. Their relations with regard to each other are as follows: The axillary vein lies in front of the artery, and rather to its thoracic side. The brachial plexus of nerves is situated above the artery, and on a posterior plane. The plexus consists of two, or sometimes three, large cords, which result from the union of the anterior branches of the four lower cervical, and the first dorsal, nerves. The course and relations of the axillary artery will be examined subsequently.

THORACIC AXIS AND BRANCHES.

This is the first branch of the axillary artery. It comes off above the pectoralis minor, and soon divides into three branches—the *superior or short thoracic*, the *thoracica humeraria*, and the *thoracica acromialis*. The *superior or short thoracic* runs between the pectoralis major and minor, supplying both, and anastomosing with the intercostal and internal mammary arteries. The *thoracica humeraria* descends with the cephalic vein, in the interval between the pectoralis major and deltoid, and ramifies in both. The *thoracica acromialis* passes over the coracoid process to the under surface of the deltoid, which it supplies, and communicates with the posterior circumflex, a branch of the axillary, and the supra-scapular, a branch of the subclavian. A constant though small branch, the clavicular, given off from this axis, runs along the anterior aspect of the subclavius. All these arteries are accompanied by veins, which most frequently empty themselves into the cephalic, but occasionally into the axillary vein.

CEPHALIC VEIN.

The cephalic vein is one of the principal cutaneous veins of the arm. Commencing on the

back of the thumb and forefinger, it runs up the radial side of the forearm, in front of the elbow-joint; thence ascending along the outer edge of the biceps, it runs up the interval between the pectoralis major and deltoid, pierces the costo-coracoid membrane, and finally empties itself into the axillary vein.*

ANTERIOR THORACIC NERVES.

These nerves come from the brachial plexus below the clavicle to supply the pectoral muscles. There are generally two—an external and an internal—one for each pectoral muscle. The *external*, the more superficial, arises from the outer cord of the brachial plexus, passes over the axillary artery, and supplies the pectoralis major; the *internal* comes from the internal cord, and runs between the axillary artery and vein, to the under surface of the pectoralis minor.

DIFFICULTY OF TYING THE FIRST PART OF THE AXILLARY ARTERY.

From this view of the relations of the axillary artery in the first part of its course, some idea may be formed of the difficulty of passing a ligature round it in this situation. In addition to its great depth from the surface, varieties sometimes occur in the position of the nerves and veins, which renders the operation still more embarrassing. For instance, the anterior thoracic nerves may be more numerous than usual, and form by their mutual communication a plexus around the artery. A large nerve is often seen crossing obliquely over the artery, immediately below the clavicle, to form one of the roots of the median nerve. The cephalic vein may ascend higher than usual, and open into the subclavian; and as it receives large veins corresponding to the thoracic axis, a concourse of veins would be met with in front of the artery. Again, it is by no means uncommon to find a deep-seated vein, the suprascapular, crossing over the artery to join the axillary vein.

* The cephalic vein, in some cases, runs over the clavicle to join the external jugular; or there may be a communication (termed jugulo-cephalic) between these veins.

DISSECTION OF THE AXILLA.

SEBACEOUS GLANDS. On the under surface of the skin of the axilla, near the roots of the hairs, are numerous sebaceous glands. They are of a reddish-brown colour, and rather larger than a pin's head.

AXILLARY FASCIA. This dense fascia, which lies immediately beneath the skin of the axilla, is a continuation of the general investment of the muscles. It closes in and forms the floor of the cavity of the axilla. Externally, it is strengthened by fibres from the tendons of the pectoralis major and latissimus dorsi, and is continuous with the fascia of the arm; internally, it is prolonged on the side of the chest, over the serratus magnus muscle; in front and behind it divides, so as to inclose between its layers the muscles which form the boundaries of the axilla. Thus the anterior layer incloses the two pectoral muscles, and is connected with the coracoid process, the costo-coracoid ligament, and the clavicle; the posterior layer incloses the latissimus dorsi, and passes backwards to the spine.

A subcutaneous artery, sometimes of considerable size, is often found in the substance of the axillary fascia. It generally arises from the brachial, or from the lower part of the axillary, and runs across the floor of the axilla towards the lower edge of the pectoralis major. It is not a named branch, but should be remembered, as it would occasion much hæmorrhage if wounded in opening an abscess.

DISSECTION AND CONTENTS OF THE AXILLA. Reflect the axillary fascia, to display the boundaries and the contents of the axilla. The dissection of this space is difficult, and must be done cautiously. Bear in mind that the trunk blood-vessels and nerves run through the *upper* and *outer* part of the axilla; that the long thoracic artery runs along the *anterior* border, and the subscapular artery along the *posterior*. Commence dissecting, therefore, in the middle; break down with the handle of the scalpel the loose connective tissue, fat, and lymphatic glands, which occupy the cavity. You will soon discover some cutaneous nerves

DISSECTION OF THE AXILLA.

SEBACEOUS GLANDS.

On the under surface of the skin of the axilla, near the roots of the hairs, are numerous sebaceous glands. They are of a reddish-brown colour, and rather larger than a pin's head.

AXILLARY FASCIA.

This dense fascia, which lies immediately beneath the skin of the axilla, is a continuation of the general investment of the muscles. It closes in and forms the floor of the cavity of the axilla. Externally, it is strengthened by fibres from the tendons of the pectoralis major and latissimus dorsi, and is continuous with the fascia of the arm; internally, it is prolonged on the side of the chest, over the serratus magnus muscle; in front and behind it divides, so as to inclose between its layers the muscles which form the boundaries of the axilla. Thus the anterior layer incloses the two pectoral muscles, and is connected with the coracoid process, the costo-coracoid ligament, and the clavicle; the posterior layer incloses the latissimus dorsi, and passes backwards to the spine.

A subcutaneous artery, sometimes of considerable size, is often found in the substance of the axillary fascia. It generally arises from the brachial, or from the lower part of the axillary, and runs across the floor of the axilla towards the lower edge of the pectoralis major. It is not a named branch, but should be remembered, as it would occasion much hæmorrhage if wounded in opening an abscess.

DISSECTION AND CONTENTS OF THE AXILLA.

Reflect the axillary fascia, to display the boundaries and the contents of the axilla. The dissection of this space is difficult, and must be done cautiously. Bear in mind that the trunk blood-vessels and nerves run through the *upper* and *outer* part of the axilla; that the long thoracic artery r[illegible]long the *anterior* border, and the sub[illegible] artery alon[illegible]terior. Commence dissecting, t[illegible] the mid[illegible] down with the handle of the [illegible]oose conn[illegible] fat, and lym[illegible]tic glands, which [illegible] cavity. [illegible]n discover[illegible]aneous nerves

coming out between the ribs, and then crossing the axillary space. These nerves are the *lateral cutaneous branches of the intercostal nerves*; they perforate the intercostal spaces between the digitations of the serratus magnus, midway between the sternum and the spine, and divide into anterior and posterior branches. The *anterior* turn over the pectoralis major, to supply the skin on the front of the chest and the mammary gland. The *posterior* pass backwards over the latissimus dorsi, and are distributed to the skin covering this muscle and the scapula.

INTERCOSTO-HUMERAL NERVES. The posterior lateral branch of the second intercostal nerve requires a special description; it is larger than the others, and is called the *intercosto-humeral* because it supplies the integuments of the arm. It comes through the second intercostal space, traverses the upper part of the axilla, where it receives a branch of the lesser internal cutaneous nerve (nerve of Wrisberg), and terminates in filaments, which are distributed to the skin on the inner side of the arm, as low as the internal condyle. The corresponding branch of the third intercostal is also an *intercosto-humeral* nerve. It receives a branch from the second, and runs a similar course. The distribution of these nerves accounts for the pain down the arm which is sometimes experienced in pleurisy.

BOUNDARIES OF THE AXILLA. The axilla is a conical space, of which the summit is beneath the clavicle, and the base between the pectoralis major and the latissimus dorsi. Obviously it varies in capacity according to the position of the arm. On the *inner* side, it is bounded by the four upper ribs, covered by the serratus magnus; on the *outer*, by the humerus, covered by the coraco-brachialis and biceps; in *front*, by the pectoralis major and minor; *behind*, by the latissimus dorsi, teres major, and subscapularis. Its anterior and posterior boundaries converge from the chest, so that the axilla becomes narrower towards the arm. With a full view of the axilla before you, bear in mind that pus may burrow under the pectoral muscles, or under the scapula, or that it may run up beneath the clavicle and point in the neck, if the abscess be allowed to remain unopened.

Axillary Lymphatic Glands. The axillary glands form a continuous chain, beneath the clavicle, with the cervical glands. They are from ten to twelve in number, of a reddish-brown colour, and variable size. Most of them lie near some large blood-vessel; others are embedded in the loose tissue of the axilla; sometimes one or two small ones are observed along the lower border of the pectoralis major. They are supplied with blood by a branch—*thoracica alaris*—of the axillary artery, and by branches from the thoracic and subscapular arteries.

These glands receive the lymphatics from the arm, from the front and side of the chest, and from the outer half of the mammary gland. From these glands the efferent lymphatics pass along with the subclavian artery and terminate, on the right side, in the right lymphatic duct, and on the left side, in the thoracic duct.

Dissection. Now reflect the pectoralis major from its origin, to expose the pectoralis minor, and the ramifications of the short and long thoracic arteries. Preserve the arteries, as far as possible, in connection with the main trunks.

Pectoralis Minor. This muscle *arises* from the third, fourth, and fifth ribs, near the costal cartilages, and from the thick fascia over the intercostal spaces. The fibres run obliquely upwards and outwards, and converge to a strong tendon, which is *inserted* into the anterior surface of the coracoid process. The tendon is connected to that of the coraco-brachialis and biceps by a strong fascia, which forms a protection for the subjacent axillary vessels and nerves. The action of this muscle is to draw the scapula downwards and forwards. Its nerve is derived from the internal anterior thoracic.

Dissection. Having examined the muscles which form the anterior boundary of the axilla, we pass now to the course and relations of the axillary artery and its branches. To have a clear view, reflect the subclavius from its insertion, and the pectoralis minor from its origin.

Axillary Artery, its course and relations. This artery, the continuation of the subclavian, takes the name of *axillary* at the outer border of the first rib. It then passes downwards and out-

wards, through the upper part of the axilla, beneath the two pectoral muscles, and along the inner border of the coraco-brachialis, as far as the lower border of the tendon of the teres major, beyond which it is continued under the name of the brachial. Its course is divided for convenience of description into three parts: the first lies above the pectoralis minor; the second behind that muscle; and the third below it.

In the *first* part of its course, the artery is covered by the pectoralis major and the costo-coracoid membrane, and is crossed by the cephalic and acromio-thoracic veins. On its inner side, and slightly in front, is the axillary vein; on its outer side is the brachial plexus of nerves; behind it are the first intercostal space, the second digitation of the serratus magnus, and the posterior thoracic nerve (external respiratory of Bell).

In the *second* part of its course, it lies behind the pectoralis major and minor; on its inner side is the axillary vein, still slightly anterior, but separated from the artery by the inner cord of the brachial plexus; on its outer side is the outer cord of the brachial plexus; and behind it is a quantity of loose connective tissue which separates it from the subscapularis muscle. The inner head of the median nerve is often in front of the artery in this part of its course.

In the *third* part, in front of the artery, are the pectoralis major, the two roots of the median nerve, converging like the letter V, and lower down is the fascia of the arm; on the outer side are the coraco-brachialis, the musculo-cutaneous and median nerves; on the inner side are the axillary vein, the ulnar, and the two internal cutaneous nerves; behind it are in succession the subscapularis, the latissimus dorsi, the teres major, and the musculo-spiral and circumflex nerves.

Branches of the Axillary Artery. The number and origin of these branches often vary, but their general course is in most cases similar, and they usually arise in the following order:—

a. The *thoracic axis* arises above the pectoralis minor, and divides into branches, which have been already described (p. 259)

b. The *alar thoracic*, variable in its origin, supplies the lymphatic glands and the connective tissue of the axilla.

c. The *inferior or long thoracic artery* (external mammary) runs along the lower border of the pectoralis minor. It supplies the mammary gland, the serratus magnus and pectoral muscles, and maintains a free anastomosis with the short thoracic, internal mammary, and intercostal arteries.

d. The *subscapular* is the largest branch of the axillary; it arises opposite the lower border of the subscapularis, and soon divides into an anterior and posterior branch.

The *anterior branch* runs along the anterior edge of the subscapularis towards the lower angle of the scapula. Its numerous branches

Fig. 52.

PLAN OF THE BRANCHES OF THE AXILLARY ARTERY.

1. Thoracic axis, giving off
   2. Short thoracic.
   3. Thoracica acromialis.
   4. Thoracica humeraria.
5. Long thoracic.
6. Subscapular.
7. Dorsalis scapulæ.
8. Anterior circumflex.
9. Posterior circumflex.

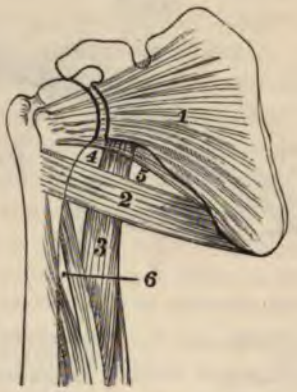
supply the subscapularis, latissimus dorsi, serratus magnus, and teres major, and anastomose with the intercostal and thoracic arteries, and the posterior scapular (a branch of the subclavian).

The *posterior branch* (dorsalis scapulæ) runs to the back of the scapula, through a triangular space, bounded in front by the long head of the triceps; below, by the teres major; and above, by the subscapular and teres minor (diagram, p. 266). On the back of the scapula, it divides into branches, which ramify close to the bone, supplying the infra-spinatus and teres minor, and anastomose with the supra-scapular and posterior scapular arteries (diagram, p. 69). The subscapular vein empties itself into the axillary vein.

CIRCUMFLEX ARTERIES, ANTERIOR AND POSTERIOR.

There are two circumflex arteries—an *anterior* and a *posterior*, so called from the manner in which they encircle the neck of the humerus. The *posterior circumflex artery* is as large as the subscapular, close to which it is given off; or both may arise from a common trunk from the axillary. It passes backwards through a quadrilateral space, bounded above by the subscapularis and teres minor, below by the teres major, externally by the neck of the humerus, and internally by the long head of the triceps (fig. 53). It then winds round the back of the neck of the

FIG. 53.



1. Subscapularis.
2. Teres major.
3. Long head of triceps.
4. Square space for circumflex a. and n.
5. Triangular space for dorsalis scapulæ a.
6. Space for musculo-spiral n., and superior profunda a.

DIAGRAM OF THE ORIGINS OF THE TRICEPS.

humerus, and is chiefly distributed to the under surface of the deltoid.

Besides the deltoid, the posterior circumflex artery supplies the long head of the triceps, the head of the humerus, and the shoulder-joint. It inosculates above with the acromio-thoracic and suprascapular arteries, below with the ascending branch of the superior profunda (a branch of the brachial), and in front with the anterior circumflex artery. Should you not find the posterior circumflex artery in its normal position, look for it (as a branch of the brachial) below the tendon of the teres major.

The *anterior circumflex artery*, much smaller than the posterior, runs in front of the neck of the humerus, above the tendon of the latissimus dorsi. It passes directly outwards beneath the coraco-brachialis and short head of the biceps, close to the bone, and terminates in the under surface of the deltoid, where it inosculates with the posterior circumflex.

The anterior circumflex artery sends a small branch which runs with the long tendon of the biceps up the groove of the humerus, and is called, on that account, the *bicipital* artery. It supplies the shoulder-joint and the neck of the humerus.*

AXILLARY VEIN. The *axillary vein* is formed by the junction of the venæ comites of the brachial artery, near the lower border of the subscapularis. It receives the subscapular and the other veins corresponding to the branches of the axillary artery, with the exception of the circumflex, which usually join either the subscapular or one of the venæ comites. The axillary also receives the cephalic, and sometimes the basilic vein.

The axillary vein in the first part of its course lies in front of the artery, and close to its sternal side; in the lower two-thirds of its course the vein lies still to the sternal side of the artery, but is separated from it by some of the nerves of the brachial plexus.

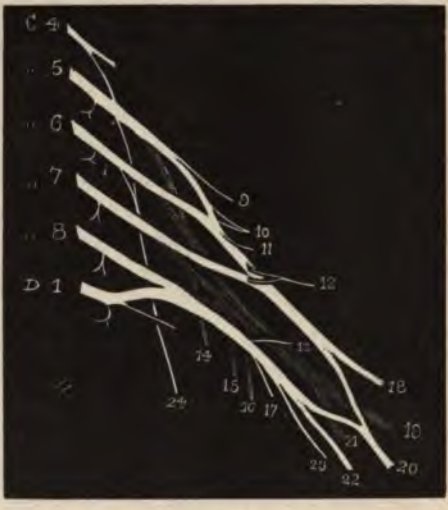
AXILLARY OR BRACHIAL PLEXUS OF NERVES. This plexus is formed by the anterior trunks of the four lower cervical and first dorsal nerves, and receives also a small communicating branch from the fourth cervical nerve. The plexus is broad at the lower part of the neck, where it emerges between the anterior and middle scalene muscles; but it gradually contracts as it descends beneath the clavicle into the axilla.

The arrangement of the cervical nerves in the formation of the plexus is variable, often not alike on both sides. The most frequent disposition is this—the fifth and sixth cervical unite to form a single cord; the eighth and the first dorsal form another cord;

* If the axillary were tied below the pectoralis minor, the collateral circulation would be established by the supra-scapular and its branches anastomosing with the subscapular, the dorsalis scapulæ, and the posterior circumflex: the posterior scapular with the dorsalis scapulæ and subscapular.

the seventh cervical runs alone for a short distance. Each of these nerves divides into an anterior and a posterior branch; the anterior branches given off from the fifth, sixth, and seventh cervical form the *outer cord* of the plexus; the anterior branches given off from the eighth cervical and the first dorsal form the *inner cord*; while

FIG. 54.



THE BRACHIAL PLEXUS OF NERVES.

C 4–8. The five lower cervical nerves.
D 1. The first dorsal nerve.
9. The rhomboid nerve—to rhomboidei major and minor.
10. The supra-scapular nerve—to supra and infra spinati.
11. The nerve to the subclavius.
12. Outer anterior thoracic nerve—to pectoralis major
13. Inner anterior thoracic nerve—to pectoralis minor.
14, 15, 16. The subscapular nerves—to subscapularis, latissimus dorsi, and teres major.
17. Lesser internal cutaneous nerve.
18. Musculo-cutaneous nerve.
19. Musculo-spiral nerve or radial.
20. Median nerve.
21. Circumflex nerve—to deltoid and teres minor.
22. Ulnar nerve.
23. Internal cutaneous nerve.
24. External respiratory nerve of Bell, or posterior thoracic.

the posterior branches of all the nerves—viz., the fifth, sixth, seventh, eighth cervical and the first dorsal—unite to form the *posterior cord*.

The axillary plexus gives off some branches above the clavicle, which were dissected with the neck (p. 72). Below the clavicle, it gives off the following:—

From the *outer* cord proceed an anterior thoracic branch, the musculo-cutaneous, and the outer head of the median; from the *inner* cord proceed the inner anterior thoracic nerve, the inner head of the median, the ulnar, the internal cutaneous, and the lesser internal cutaneous; from the *posterior* cord proceed the three subscapular nerves, the circumflex and the musculo-spiral.

The anterior thoracic nerves have been described (p. 260).

SUBSCAPULAR NERVES. The *three subscapular* nerves are found on the surface of the subscapularis. They come from the posterior cord of the brachial plexus, and supply, respectively, the latissimus dorsi, teres major, and subscapularis. The nerve for the latissimus dorsi (*long subscapular nerve*) runs with the anterior branch of the subscapular artery to the lower border of the muscle.

The *nerve for the teres major* is either a branch of the preceding, or comes separately from the posterior cord. It lies nearer to the humerus than the long subscapular.

The *nerve of the subscapularis* arises from the posterior cord higher than the others, and enters the muscle not far from its upper border in company with a small artery.

CIRCUMFLEX NERVE. The circumflex nerve accompanies the posterior *circumflex artery*. This large nerve comes from the posterior cord, and, after giving a small filament to the shoulder-joint, passes, with its companion artery, through the quadrilateral space (p. 266) to the under surface of the deltoid. Here the nerve divides into an upper and a lower branch. The *upper* supplies the anterior part of the deltoid and the skin over it; the *lower* supplies the back part of the deltoid, and gives the nerve to the teres minor,* upon which nerve sometimes a little gangliform swelling can be seen. After furnishing these muscular branches, the nerve turns round the posterior border of the deltoid, and diverges

* This branch to the teres minor is said to be constant in all mammalia that have been examined in reference to this point.

in filaments which supply the skin over the back of this muscle and over the long head of the triceps.

LATISSIMUS DORSI. This muscle forms the posterior margin of the axilla. It *arises* from the crest of the ilium, from the spines of the two or three upper sacral, all the lumbar, and six lower dorsal vertebræ, and by digitations from the three lower ribs, corresponding with those of the external oblique; in some cases, as it passes over the inferior angle of the scapula, it has an additional origin from the angle. It is *inserted* by a broad flat tendon, which runs behind the axillary vessels and nerves, into the bottom of the bicipital groove of the humerus. Its nerve is the long subscapular branch of the brachial plexus.

TERES MAJOR. This muscle lies behind the latissimus dorsi, is closely connected with it, and assists in forming the posterior boundary of the axilla. It *arises* from the lower angle of the back of the scapula, and is *inserted* by a broad flat tendon into the posterior margin of the bicipital groove of the humerus. A bursa or sac, containing serum, to diminish friction, intervenes between this tendon and that of the latissimus dorsi. The action of this and the preceding muscle is to draw the humerus inwards and backwards. Its nerve is the middle subscapular.

SUBSCAPULARIS. This muscle *arises* from the internal surface of the scapula, with the exception of the angles and neck, and from intermuscular septa attached to the bony ridges. Its fibres terminate on a strong tendon, which passes under the axillary vessels and nerves, over the inner side of the shoulder-joint, and is *inserted* into the lesser tuberosity of the humerus. The tendon of the muscle is intimately connected with the capsular ligament of the shoulder-joint, and between the coracoid process and the tendon is a bursa, which frequently communicates with the joint. Its action is to rotate the humerus inwards. Its nerve comes from the posterior cord of the brachial plexus.

SERRATUS MAGNUS. This muscle covers the side of the chest like a girth. It *arises* from the eight upper ribs by nine slips or digitations, the second rib having two. Its fibres

converge and are *inserted* into the posterior border of the scapula in the following manner: the first two digitations are attached into the upper angle of the scapular; the third and fourth digitations along nearly the whole length of the posterior border; the remainder are inserted into the inferior angle. Its action is to draw the scapula forwards; but of this more hereafter. It is supplied by the following nerve, which is seen on its outer surface.

POSTERIOR THORACIC OR EXTERNAL RESPIRATORY NERVE OF BELL.

This nerve supplies the serratus magnus only. It comes from the fifth and sixth cervical nerves; and, after passing through the scalenus medius, runs behind the axillary vessels, along the outer surface of the serratus magnus, each digitation receiving a separate filament.*

DISSECTION OF THE UPPER ARM.

DISSECTION.

Continue the incision down the inner side of the arm as far as two inches below the elbow. Reflect the skin, and trace out the cutaneous nerves, and the numerous veins in front of the elbow.

CUTANEOUS NERVES.

On the inner side of the arm are the intercosto-humeral, the internal cutaneous branch of the musculo-spiral, the internal cutaneous and the lesser internal cutaneous (nerve of Wrisberg) nerves; on the outer side are the cutaneous branches of the circumflex, the external cutaneous branches of the musculo-spiral, and lower down is the musculo-cutaneous nerve.

The filaments of the *intercosto-humeral nerves* (p. 262) descend along the inner and posterior part of the arm as far as the olecranon.

The branches of the *internal cutaneous nerve* perforate the fascia about the middle of the arm, and divide into an anterior and a posterior branch; the anterior passes down in front of the arm (as a rule beneath the median basilic vein), and supplies the skin as far as the wrist; the

* It may be asked why this nerve is called the external respiratory. It was so named by Sir C. Bell, who considered the serratus magnus as the external respiratory muscle, co-operating with the diaphragm or internal respiratory muscle.

posterior winds round to the back of the forearm behind the internal condyle, and communicates with the nerve of Wrisberg and the ulnar nerve.

The *lesser internal cutaneous* (*nerve of Wrisberg*) perforates the fascia about the lower third of the arm, and supplies the skin over the internal condyle and the olecranon. This nerve, as it lies close to the

Fig. 55.

1. Acromial branches } of the superficial cervical plexus.
2. Clavicular branches }
3. Cutaneous branches of the circumflex nerve.
4. Branches of the internal cutaneous nerve.
5. External cutaneous branch of the musculo-spiral nerve.
6. Internal cutaneous nerve.
7. Its posterior cutaneous branch.
8. The cutaneous branch of the musculo-cutaneous nerve.

DISTRIBUTION OF CUTANEOUS NERVES TO THE FRONT OF THE SHOULDER AND ARM.

axillary vein, communicates with the first or second intercosto-humeral nerve.

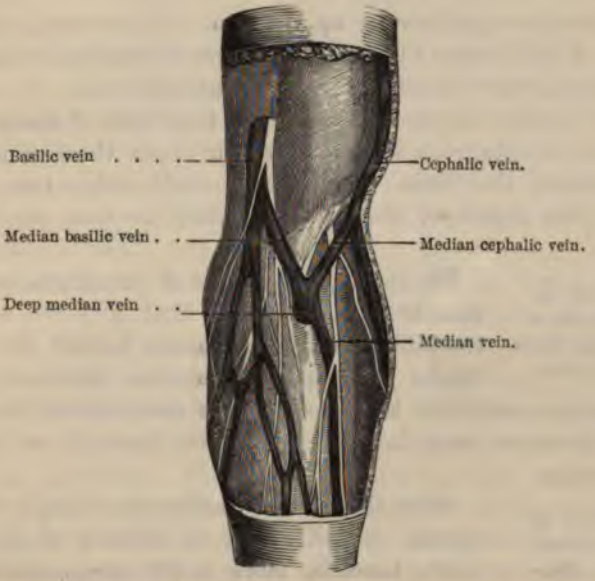
The *internal cutaneous branch of the musculo-spiral nerve* pierces the fascia, and supplies the skin of the inner side of the middle of the arm.

The *cutaneous branches of the circumflex nerve* pierce the fascia over the insertion of the deltoid, and supply the skin of the upper half of the arm on its outer side.

The *external cutaneous branches of the musculo-spiral nerve* are two in number: the upper and smaller accompanies the cephalic vein in the lower half of the arm; the lower may be traced down the outer and back part of the forearm nearly as far as the wrist, where it joins the musculo-cutaneous nerve.

On the outer side of the tendon of the biceps, the cutaneous branch of the musculo-cutaneous nerve perforates the fascia, and divides into many filaments, which supply the skin of the outer part of the forearm.

Fig. 56.



SUPERFICIAL VEINS AND NERVES AT THE BEND OF THE LEFT ELBOW.

Disposition of Veins in front of the Elbow.

Attention should now be directed to the disposition of the veins in front of the elbow. In cleaning these veins, take care not to divide the branches of the internal and external cutaneous nerves which pass over and under them.

The following is the ordinary arrangement of the superficial

veins at the bend of the elbow (fig. 56). On the outer side is the radial; on the inner side is the ulnar vein, formed by the junction of the anterior and posterior ulnar cutaneous veins; in the centre is the median, which divides into two branches, the external of which, uniting with the radial to form the cephalic vein, is called the *median cephalic*; the internal, uniting with the ulnar to form the basilic, is named the *median basilic*. Near its bifurcation, the median vein communicates by a branch (mediana profunda) with the deep veins which accompany the arteries of the forearm.

Trace the *cephalic vein* up the arm. It runs along the outer border of the biceps to the groove between the pectoralis major and the deltoid, where it terminates in the axillary vein.

The *basilic vein* ascends along the inner side of the arm with the internal cutaneous nerve. Near the upper third of the arm, it perforates the fascia, and empties itself either into the internal vena comes of the brachial artery or into the axillary vein.

RELATION OF THE CUTANEOUS NERVES AND VEINS AT THE ELBOW.

The principal branches of the cutaneous nerves pass beneath the veins: that is to say, as a rule, the internal cutaneous passes behind the median basilic vein, and the external cutaneous behind the median cephalic: but it should be remembered that many small filaments cross in front which are exposed to injury in venesection.

RELATION OF MEDIAN BASILIC VEIN TO BRACHIAL ARTERY.

Since the median basilic vein is larger than the median cephalic, and, on account of the strong fascia beneath, more easily compressible, it is usually chosen for venesection; its position, therefore, in reference to the brachial artery, becomes important. The vein is only separated from the artery by the semilunar fascia, derived from the tendon of the biceps. This fascia is in some subjects remarkably thin. Sometimes the artery lies above the fascia, in contact with the vein. In choosing, therefore, this vein for venesection, there is a risk of wounding the artery; hence the practical rule, to bleed either from the median cephalic, or

from the median basilic above the situation where it crosses the brachial artery.

LYMPHATIC GLANDS. Immediately above the internal condyle, in the neighbourhood of the basilic vein, we find one or two small *lymphatic glands*. Others may be higher up along the inner side of the arm. A gland is occasionally met with at the bend of the elbow; but never below this joint. These little glands are the first which are liable to become tender and enlarged after a poisoned wound of the hand.

MUSCULAR FASCIA AND ITS CONNECTIONS. The fascia which invests the muscles of the upper arm is a continuation of the fascia of the trunk and the axilla. This membrane varies in density; thus it is thin over the biceps, stronger on the inner side of the arm, to protect the brachial vessels and nerves, and strongest over the triceps. At the upper part of the arm it is connected with the coracoid process and the clavicle; it is strengthened at the axilla by an expansion from the tendons of the pectoralis major and latissimus dorsi; posteriorly, it is attached to the spine of the scapula. The fascia surrounds the brachial vessels with a sheath, and furnishes partitions which separate the muscles from each other. Of these partitions, the most marked are the *external* and *internal intermuscular septa*, which divide the muscles on the anterior from that on the posterior surface of the upper arm. These septa are attached to the condyloid ridges of the humerus and to the condyles. The *internal intermuscular septum*, the stronger of the two, begins at the insertion of the coraco-brachialis, and separates the triceps extensor from the brachialis anticus. The *external intermuscular septum* commences from the insertion of the deltoid, and separates the brachialis anticus, the supinator longus, and the extensor carpi radialis longior in front, from the triceps extensor behind.

At the lower part of the upper arm, the fascia is remarkably strong, especially where it covers the brachialis anticus, and the brachial vessels, and is continued over the muscles on the inner side of the forearm. At the back of the elbow, the fascia is attached to the tendon of the triceps, and the olecranon.

DISSECTION. Now remove the fascia in order to see the muscles on the front of the arm—namely, the biceps, the coraco-brachialis, and the brachialis anticus.

BICEPS. The biceps, as its name implies, arises by two heads—a long and a short. The *short head arises* from the point of the coracoid process of the scapula, by a thick, flat tendon in common with a slender muscle on its inner side, called the coraco-brachialis. The *long head arises* from the upper border of the glenoid fossa of the scapula and the glenoid ligament, by a long, rounded tendon, which, traversing the shoulder-joint, passes over the head of the humerus, and down the groove between the two tuberosities. The tendon is retained in the groove by a fibrous bridge derived from the capsule of the joint, and connected with the tendon of the pectoralis major. Divide this bridge, and see that the synovial membrane of the joint is reflected round the tendon, and accompanies it for about two inches down the groove, thus forming a synovial fold. The object of this is to facilitate the play of the tendon, and to carry little arteries (from the anterior circumflex) for its supply. The two heads unite about the middle of the arm, and form a single muscle, which terminates on a strong flat tendon of considerable length; this dips down into the triangular space at the bend of the elbow, and, after a slight twist upon itself, is *inserted* into the posterior part of the tubercle of the radius. The anterior part of the tubercle, over which the tendon plays, is crusted with cartilage, and a *bursa* intervenes to diminish friction. The most internal fibres of the muscle are inserted into a *strong broad aponeurosis*, which is prolonged from the inner border of the tendon to the fascia on the inner side of the forearm. This aponeurosis, called the *semi-lunar fascia of the biceps*, protects the brachial vessels and the median nerve at the bend of the elbow.

The *action* of the biceps is twofold. 1. It is a flexor of the forearm. 2. It is a powerful supinator of the forearm, in consequence of its insertion into the *posterior* part of the tubercle of the radius. Its power of supination is greatest when the forearm

is half bent, because its tendon is then inserted at a right angle. Why does the long tendon pass through the shoulder-joint? It acts like a strap, and confines the head of the humerus in its proper centre of motion. But for this tendon, the head of the bone, when the deltoid acts, would be pulled directly upwards and strike against the under surface of the acromion. When the tendon is ruptured, or dislocated from its groove, a man can move his arm backwards and forwards, but he cannot raise the smallest weight.* The biceps is supplied with blood by a branch from the brachial, which runs into the middle of its inner side and divides into ascending and descending branches. Its nerve comes from the musculo-cutaneous.

CORACO-BRACHIALIS. This thin muscle is situated at the upper part of the arm, and runs parallel to the inner border of the short head of the biceps. It *arises* by fleshy fibres from the point of the coracoid process, in common with the short head of the biceps, and from a fibrous septum which lies between them. The muscle terminates on a flat tendon, which is *inserted* into the inner side of the middle of the humerus, between the brachialis anticus and the inner head of the triceps. Its action is to draw the humerus forwards and inwards—*e.g.* in bringing the gun up to the shoulder. It is supplied by a branch from the musculo-cutaneous nerve which passes through it.

Concerning the coraco-brachialis remember, 1. That the musculo-cutaneous nerve runs through it; 2. That its inner fleshy border is the guide to the axillary artery in the last part of its course; 3. That the brachial artery lies upon its flat tendon of insertion, and can here be effectually compressed by the finger or the tourniquet.

The coraco-brachialis and biceps are covered at their upper part by the deltoid and pectoralis major. The head of the humerus rolls beneath the coraco-brachialis and short origin of the biceps; and a large *bursa* is interposed between these muscles and the tendon of the subscapularis, which covers the head of the bone.

* See a preparation in the Museum of St. Bartholomew's Hospital, ser. v. 9.

BRACHIALIS ANTICUS. This muscle is situated upon the lower half of the humerus, and is partially concealed by the biceps. Between the two muscles is the musculo-cutaneous nerve, which supplies them both.

It *arises* from the humerus by a fleshy digitation on either side of the tendon of the deltoid; from the lower half of the front surface of the bone, and from the intermuscular septa. The muscle, becoming thicker and broader, covers the front of the capsule of the elbow-joint to which it is more or less attached, and terminates on a tendon, which is *inserted* in a pointed manner into the coronoid process of the ulna. Its *action* is to bend the forearm. Its nerves come from the musculo-cutaneous. Sometimes the brachialis anticus receives in addition a small branch from the musculo-spiral.

Now examine the course and relations of the brachial vessels and nerves.

COURSE AND RELATIONS OF THE BRACHIAL ARTERY. The brachial artery—the continuation of the axillary—takes its name at the lower border of the teres major. It runs down the inner side of the arm, along the *inner border of the coraco-brachialis and biceps*, to about an inch below the elbow, where it divides, near the coronoid process of the ulna, into the radial and ulnar arteries.

Thus its direction corresponds with a line drawn from the deepest part of the axilla to the middle point between the condyles of the humerus.

In the upper part of its course it lies on the long and inner heads of the triceps (from the long head it is separated by the musculo-spiral nerve and superior profunda artery); in the middle, it lies on the tendon of the coraco-brachialis; in the lower part, on the brachialis anticus.

The artery is accompanied by two veins (*venæ comites*), and the median nerve, all of which are invested in a common sheath of fascia. The *median* nerve crosses obliquely in front of the artery, lying, near the axilla, on its outer side; near the elbow, on its inner.

The *ulnar* nerve runs along the inner side of the artery as far as the middle of the arm. Below this point, the nerve leaves the artery, and passes through the intermuscular septum to get behind the internal condyle.

Superficial to the artery, are the internal cutaneous nerve and the basilic vein.

The artery is more or less overlapped, in the first part of its course, by the coraco-brachialis, lower down by the fleshy belly of the biceps; the inner borders of these muscles, in their respective situations, being the best guides to the artery.

About the middle of the humerus, the artery lies for nearly two inches on the tendon of the coraco-brachialis, and is so close to the bone that it can be effectually compressed, provided the pressure be made in the proper direction—namely, outwards; here, too, it is crossed by the median nerve.

At the bend of the elbow the artery is crossed by the semilunar fascia from the biceps. It enters a triangular space, bounded by the pronator radii teres internally, and by the supinator radii longus externally. It sinks into this space, with the tendon of the biceps to its outer side, and the median nerve to its inner; all three rest upon the brachialis anticus. To compress the artery here, pressure should be made directly backwards. Opposite the coronoid process of the ulna it divides into the radial and ulnar arteries.

Two veins, of which the internal is the larger, lie in close contact with the brachial artery, and communicate at frequent intervals by transverse branches. Near the axilla they join and form the axillary vein.

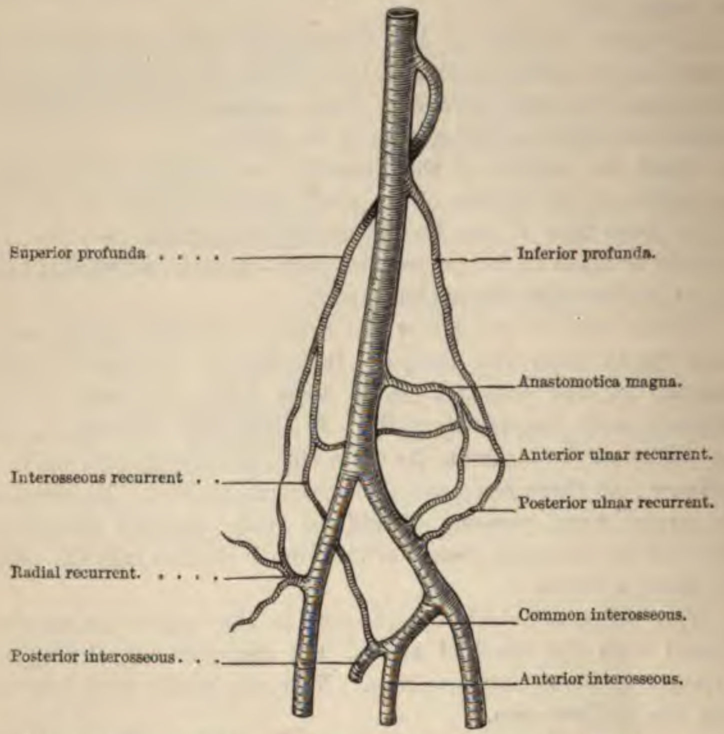
BRANCHES OF BRACHIAL ARTERY. The brachial artery gives off three branches, all from its inner side: namely, the superior profunda, the inferior profunda, and the anastomotica magna. It also distributes muscular branches (to the coraco-brachialis and biceps), which are given off from its outer side.

a. The *profunda superior* arises from the brachial artery, immediately below the tendon of the teres major.* It winds round the back of

* If the profunda be not in its usual place, look for it above the tendon of the

the humerus, between the outer and inner heads of the triceps, accompanied by the musculo-spiral nerve, and, a little above the middle of the arm, divides into two branches, which run for some distance on either side of the nerve. One of these runs in the substance of the

Fig. 57.



PLAN OF THE CHIEF BRANCHES OF THE BRACHIAL ARTERY AND THE ARTERIAL INOSCULATIONS ABOUT THE RIGHT ELBOW-JOINT.

triceps muscle, with the nerve to the anconeus, as far as the olecranon, and anastomoses with the posterior ulnar recurrent, the interosseous recurrent, and anastomotica magna arteries: the other branch accompanies

latissimus dorsi, where it will probably be given off from a common trunk with the posterior circumflex.

the musculo-spiral nerve to the outer side of the arm, where it perforates the external intermuscular septum. It then descends deep in the fissure between the brachialis anticus and supinator radii longus, and terminates in numerous ramifications, some of which pass in front of the external condyle, others behind it, to inosculate with the radial and interosseous recurrent arteries.

Before its division, the superior profunda sends several branches to the triceps, some of which inosculate with the circumflex. These assist in establishing a collateral circulation when the brachial artery is ligatured above the origin of the profunda.

b. The *profunda inferior* arises from the brachial, opposite to the insertion of the coraco-brachialis, or sometimes by a common trunk with the superior profunda. It runs with the ulnar nerve on the inner head of the triceps (which it supplies), passes through the internal intermuscular septum, and then descends to the interval between the internal condyle and the olecranon, inosculating with the posterior ulnar recurrent and anastomotica magna arteries.

The *nutrient artery* of the humerus arises sometimes from the brachial, sometimes from the interior profunda. It pierces the tendon of the coraco-brachialis, runs obliquely downwards through the bone, and in the medullary canal divides into ascending and descending branches, which anastomose with the nutrient vessels of the bone derived from the periosteum.

c. The *anastomotica magna* arises from the inner side of the brachial, about two inches above the elbow, runs tortuously inwards across the brachialis anticus, and divides into branches, some of which pass in front of the internal condyle, anastomosing with the anterior ulnar recurrent artery; others pass behind the internal condyle and anastomose with the inferior profunda and posterior ulnar recurrent arteries; and one branch forms an arch, above the olecranon fossa, with the superior profunda.

d. Numerous *muscular branches* arise from the outer side of the brachial artery; one of these, the bicipital, more constant than the rest, supplies the biceps; another runs transversely beneath the coraco-brachialis and biceps, over the insertion of the deltoid, supplying this muscle and the brachialis anticus.

VENÆ COMITES. The two veins which accompany the brachial artery are continuations of the deep radial and ulnar veins. The internal is usually the larger, and generally receives the veins corresponding to the principa branches of the

artery. In their course they are connected at intervals by transverse branches either in front of, or behind the artery. Near the subscapularis, the *vena comes externa* crosses obliquely in front of the axillary artery to join the *vena comes interna*, which then takes the name of axillary.

Now trace the great nerves of the upper arm, which proceed from the brachial plexus near the tendon of the subscapularis: namely, the median, the musculo-cutaneous, the ulnar, and the musculo-spiral or radial.

MEDIAN NERVE. The median nerve arises by two roots, which converge in front of the axillary artery (p. 264). The external root is derived from a trunk in common with the musculo-cutaneous; the internal from a trunk in common with the ulnar and internal cutaneous. In its course down the arm, the nerve is situated at first on the outer side of the brachial artery, between it and the coraco-brachialis; about the middle of the arm the nerve crosses obliquely over (in some cases under) the vessel, so that at the bend of the elbow it is found on the inner side of the artery, lying upon the brachialis anticus, and covered by the semilunar fascia from the biceps.*

* I have observed the following *varieties* relating to the median nerve, and its course in regard to the artery.

a. The roots may be increased in number by one on either side of the artery; or the internal root may be deficient.

b. They may vary in their position with regard to the artery; both may be situated behind the vessel, or one behind, and the other in front of it.

c. The nerve, formed in the usual manner, may be joined lower down by a large branch from the external cutaneous; such a case presents a junction of two large nerves in front of the brachial artery, in the middle of the arm.

d. The nerve in many cases crosses under, instead of over the artery.

e. The nerve sometimes runs parallel and external to the artery; or it may run parallel to, and in front of, the artery.

In one hundred arms the relative position of the nerve to the artery in its course down the arm was as follows:—

In 72, the nerve took the ordinary course.
„ 20, the nerve crossed obliquely under the artery.
„ 5, the nerve ran parallel and superficial to the artery.
„ 3, the nerve ran parallel and external to the artery.

These varieties of the median nerve are of practical importance, for this reason:

As a summary of the distribution of the median nerve, we may say that it supplies the two pronators and all the flexors of the forearm (except the flexor carpi ulnaris and the ulnar half of the flexor profundus digitorum); the muscles of the ball of the thumb, the two radial lumbricales, both sides of the thumb, fore and middle fingers, and the radial side of the ring finger.

MUSCULO-CUTANEOUS NERVE. This nerve (often called the external cutaneous) arises in common with the external root of the median from the external cord of the brachial plexus behind the pectoralis minor, and is situated on the outer side of the axillary artery. It perforates the coraco-brachialis obliquely, and then runs down between the biceps and the brachialis anticus. A little above the elbow-joint, between the tendon of the biceps and the supinator radii longus, the nerve becomes subcutaneous, and, passing under the median cephalic vein, divides into branches, for the supply of the integuments of the forearm.

The musculo-cutaneous nerve, in the upper part of its course, sends branches to the coraco-brachialis and the short head of the biceps, and, as it descends between the biceps and the brachialis anticus, it supplies both. Consequently, if the nerve were divided in the axilla, the result would be inability to bend the arm.* This nerve also sends small filaments to supply the elbow-joint.

ULNAR NERVE. This nerve arises from the inner cord of the brachial plexus, in common with the internal cutaneous and the inner head of the median. It descends along the inner side of the brachial artery, as far as the insertion of the

whenever, in the operation of tying the brachial artery, we do not find the nerve in its normal position, we may expect to find some irregular distribution of the arteries—*e.g.* a high division of the brachial, or even, which I have often seen, a 'vas aberrans' coming from the upper part of the brachial, and joining either the radial or ulnar arteries.

* In some instances the musculo-cutaneous nerve descends on the inner side of the coraco-brachialis without perforating the muscle; in these cases it often sends a larger branch than usual to the median nerve.

The trunk of the musculo-cutaneous nerve may come from the median at any point between the axilla and the middle of the arm. In some subjects the nerve is absent; all its branches are then supplied by the median, which is larger than usual. Such anomalies are easily explained by the fact of the two nerves having a common origin.

coraco-brachialis. The nerve then diverges from the artery, perforates the internal intermuscular septum, and runs with the inferior profunda artery, behind the internal condyle.

The distribution of the nerve is to the flexor carpi ulnaris, to half the flexor profundus digitorum, to all the interosseous muscles of the hand, to both sides of the little finger, to the ulnar side of the ring finger, to the muscles of the ball of the little finger, to the two ulnar lumbricales, and, lastly, to the adductor pollicis, and the inner head of the flexor brevis pollicis.

Previous to the examination of the musculo-spiral nerve, we should examine the great muscle which occupies the whole of the posterior part of the humerus—viz. the triceps extensor cubiti.

TRICEPS EXTENSOR CUBITI. This muscle has three distinct origins, named from their position, the *external*, the *internal*, and the *middle* or *long* heads (p. 266). The *middle* or *long* head *arises* by a flat tendon from the inferior border of the scapula, close to the glenoid cavity. The *external* head *arises* from the humerus, beginning in a pointed form immediately below the insertion of the teres minor, and extending as low down as the musculo-spiral groove. The *internal* head *arises* from the humerus below the insertion of the teres major, from the posterior surface of the bone below the musculo-spiral groove, and from the internal intermuscular septum. The three heads unite, near the middle of the arm, to form a single fleshy mass, which covers the posterior part of the elbow-joint, and is *inserted* by a thick tendon into the summit and sides of the olecranon. Each head is supplied by a separate branch from the musculo-spiral nerve.

MUSCULO-SPIRAL NERVE. This, the largest of the brachial nerves, arises, in common with the circumflex, from the posterior cord of the axillary plexus (p. 268). It descends at first behind the axillary artery, and then winds obliquely round the posterior part of the humerus, between the external and internal heads of the triceps, in company with the superior profunda artery. About the lower third of the outer side of the arm, the nerve perforates the external intermuscular septum, and then runs deeply embedded between the brachialis anticus and the supinator radii longus.

The nerve gives off branches on the inner side of the humerus, to the inner and long heads of the triceps; on the back of the humerus, to the external head of the triceps and the anconeus; on the outer side of the humerus, to the supinator radii longus, the extensor carpi radialis longior, and the brachialis anticus (sometimes); lastly, after perforating the septum, it gives off the upper and lower external cutaneous branches.

A little above the elbow-joint the nerve divides into its two principal branches—the *radial*, which accompanies the radial artery along the forearm—and the *posterior interosseous*, which perforates the supinator brevis, and supplies the muscles on the back of the forearm.

To sum up the muscular distribution of this great nerve, we may say that it supplies *all* the extensors of the forearm, wrist, thumb, and fingers; and *all* the supinators except one—namely, the biceps (supplied by the musculo-cutaneous nerve).

DISSECTION OF THE FRONT OF THE FOREARM.

DISSECTION. Prolong the incision down to the wrist, and, at its termination, make another transversely. Reflect the skin, and dissect the subcutaneous veins and nerves.

CUTANEOUS VEINS. On the inner side is the *anterior ulnar vein*, which commences on the front of the wrist, and is then continued upwards on the inner side of the forearm as far as the elbow, where it is joined by the posterior ulnar vein to form the basilic (p. 273).

The veins on the back of the hand commence at the extremities of the fingers, run up *between* the knuckles, and unite on the back of the hand, forming an arch, with its concavity upwards. The *posterior ulnar vein* arises from this arch by a branch (vena salvatella) situated over the fourth interosseous space, and runs up on the back of the forearm towards the inner condyle, to join the anterior ulnar vein.

The *radial vein*, situated on the outer side of the forearm,

commences on the back of the hand from the venous arch, runs up the outer side of the front of the forearm to the elbow, where it becomes the cephalic.

Running up in front of the middle of the forearm is the *median vein*; near the bend of the elbow it is joined by a deep branch—*mediana profunda*—after which it divides into two branches, an outer or *median cephalic*, which joins the cephalic, and an inner or *median basilic*, which joins the basilic (fig. 56).

CUTANEOUS NERVES. On the radial side of the forearm, as low down as the wrist, are found the terminal filaments of the anterior branch of the musculo-cutaneous nerve, which, about the middle of the forearm, sends a branch backwards to supply the posterior and lower part of the forearm as low as the wrist, communicating with the radial and external cutaneous branch of the musculo-spiral. At the lower part of the forearm, one or more of these filaments are situated over the radial artery.

In front of the upper part of the forearm are some filaments of the external cutaneous branch of the musculo-spiral nerve; on the outer and back part of the forearm, near the elbow, the lower external cutaneous branch of the musculo-spiral runs down as far as the wrist to supply the skin.

At the lower third of the radial side of the forearm, the radial nerve becomes superficial, and turns over the radius to supply the back of the hand and fingers.

On the ulnar side the anterior division of the internal cutaneous nerve descends as far as the wrist; its posterior branch passing to the back of the forearm to supply it as far as the middle. Near the styloid process of the ulna, the dorsal branch of the ulnar nerve perforates the fascia to reach the back of the hand.

DEEP FASCIA OF THE FOREARM. The muscles of the forearm are enveloped by a dense shining aponeurosis, continuous with that of the arm. Its thickness increases towards the wrist, that the tendons, in this situation, may be kept in their position. It is composed of fibres which cross each other obliquely, and is attached, above, to the condyles of the humerus and olecranon; internally, to the ridge on the posterior part of the ulna. At the

back of the wrist, it forms the posterior annular ligament, and in front, it is continuous with the anterior annular ligament. Above, the fascia is strengthened by fibres from the tendons of the biceps and brachialis anticus. The aponeurotic expansion from the inner edge of the tendon of the biceps is exceedingly strong. It braces the muscles on the inner side of the forearm, and interlaces at right angles with the fibres of the fascia attached to the internal condyle. The under surface of the fascia gives origin to the muscular fibres in the upper part of the forearm, and furnishes septa which separate the muscles, and form surfaces for their origin. The fascia is perforated at various parts for the passage of the cutaneous vessels and nerves of the forearm.

DISSECTION. Remove the fascia from the muscles by incisions corresponding to those for reflecting the skin; taking care of the cutaneous branches of the median and ulnar nerves close to the wrist.

TRIANGLE AT THE ELBOW. At the bend of the elbow is a triangular space, with its base towards the humerus; on the inner side this space is bounded by the pronator teres; on the outer, by the supinator radii longus. In it are the following objects, which must be carefully dissected:—1. In the centre is the brachial artery (with its companion veins) dividing into the radial and ulnar; 2, on the outer side of the artery is the tendon of the biceps; 3, on the inner side is the median nerve; 4, the musculo-spiral nerve is partly concealed by the supinator longus; 5, the radial recurrent artery; 6, the anterior ulnar recurrent; 7, the common interosseous branch of the ulnar artery; 8, the vena mediana profunda.

MUSCLES OF THE FOREARM. The muscles of the forearm are arranged in two groups; one, consisting of supinators and extensors, is attached to the outer condyloid ridge and condyle; the other, consisting of pronators and flexors, is attached to the inner condyle. The inner group should be examined first. They arise by a common tendon, and are arranged in the following order: pronator teres; flexor carpi radialis; palmaris longus; flexor carpi ulnaris, and flexor sublimis digitorum.

Pronator Radii Teres. This muscle forms the inner boundary of the triangular space at the elbow. It *arises* from the anterior surface of the internal condyle, from the common tendon, from the fascia of the forearm, and from the septum between it and the flexor carpi radialis. It has also a small tendinous origin from the inner border of the coronoid process of the ulna. From these two origins, between which the median nerve passes, the muscle proceeds obliquely downwards, and is *inserted* by a flat tendon into a rough surface on the outer and back part of the middle third of the radius. In amputating the forearm, it is very desirable to save the insertion of this muscle, that the stump may have a pronator. Its nerve comes from the median.

Flexor Carpi Radialis. This muscle *arises* by the common tendon from the internal condyle, from the intermuscular septa, and from the fascia of the forearm. The fleshy fibres terminate near the middle of the forearm, in a flat tendon, which runs in a separate sheath outside the anterior annular ligament of the wrist, passes through a groove in the os trapezium, bridged over by fibrous tissue and lined by a synovial membrane, and is *inserted* into the base of the second metacarpal bone. The outer border of its tendon is the guide to the radial artery in the lower half of the forearm. Its nerve comes from the median.

Palmaris Longus. This slender muscle *arises* from the common tendon at the internal condyle, from the intermuscular septa, and from the fascia of the forearm. About the middle of the forearm it terminates in a flat tendon, which descends along the middle of the forearm to the wrist, lying upon the flexor sublimis digitorum; it then passes over the anterior annular ligament, and is continued into the palmar fascia. This muscle is a tensor of the palmar fascia.* Its nerve comes from the median.

Flexor Carpi Ulnaris. This muscle *arises* by two heads: one from the internal condyle, the common tendon, and the

* The palmaris longus is absent in about one out of ten subjects. The situation of its muscular portion is subject to variety; sometimes occupying the middle, sometimes the lower third of the forearm. The tendon is in some instances wholly inserted into the anterior annular ligament.

intermuscular septum; the other from the inner edge of the olecranon: these two origins form an arch, under which the ulnar nerve passes. It also *arises* from the upper two-thirds of the posterior edge of the ulna, through the medium of the aponeurosis, which is common to this muscle and the flexor profundus digitorum. The tendon appears on the radial side of the muscle, about the lower third of the forearm, and receives fleshy fibres on its ulnar side as low as the wrist. It is *inserted* into the os pisiforme, and thence by a strong tendon into the os unciforme and the base of the fifth metacarpal bone. Its nerve comes from the ulnar.

The tendon of the flexor carpi ulnaris is the guide to the ulnar artery, which lies close to its radial side, and is *overlapped* by it. As it passes over the annular ligament, the tendon furnishes a fibrous expansion to protect the ulnar artery and nerve.

FLEXOR SUBLIMIS DIGITORUM. This muscle is situated beneath those previously mentioned, and has two distinct origins. The longer *origin* takes place from the internal condyle, from the internal lateral ligament, the common tendon, the intermuscular septa, and the coronoid process of the ulna; the shorter *origin* takes place by tendinous and fleshy fibres from an oblique ridge on the front of the radius, extending from the tubercle to about an inch below the insertion of the pronator teres. This, called its *radial origin*, is partly concealed by the pronator teres. The muscle, thus formed, passes down the middle of the forearm, and divides into four distinct muscular slips: from these, four tendons arise, which pass beneath the annular ligament, arranged in two pairs; the tendons of the middle and ring fingers being placed over those of the fore and little fingers. The tendons pass through the palm to the fingers, where they split to allow the passage of the deep flexor tendons, and are *inserted* into the sides of the second phalanges. Its *action* is, therefore, to bend the second joint of the fingers.

The muscles described as arising from the internal condyle are all supplied by the median nerve, except the flexor carpi ulnaris, which is supplied by the ulnar.

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Having finished the superficial muscles on the inner side of the forearm, notice one of those on the outer side, named supinator radii longus, before tracing the vessels and nerves of the forearm.

SUPINATOR RADII LONGUS. This muscle forms the external boundary of the triangular space at the bend of the elbow. It *arises* from the upper two-thirds of the external condyloid ridge of the humerus, commencing a little below the insertion of the deltoid, and from the external intermuscular septum. The muscular fibres terminate about the middle of the forearm in a flat tendon, which is *inserted* into the outer side of the base of the styloid process of the radius. The inner border of the muscle is the guide to the radial artery. It supinates the hand, but acts much more powerfully as a flexor of the forearm. It is supplied by the musculo-spiral nerve.

RADIAL ARTERY. The radial artery, the smaller division of the brachial, runs down the radial side of the forearm to the wrist, where it turns over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, and sinks into the angle between the first and second metacarpal bones to form the deep palmar arch. Thus, its course corresponds with a line drawn from the middle of the bend of the elbow, to the front of the styloid process of the radius.

In the upper third of the forearm, the artery lies deep between the pronator teres on the inner and the supinator longus on the outer side; the fleshy border of the latter overlaps it in muscular subjects. In the lower two-thirds of the forearm the artery is more superficial, and is placed between the tendons of the supinator longus on the outer and the flexor carpi radialis on the inner side. In its course, it lies successively on the following:—first, upon the tendon of the biceps; secondly, upon the supinator radii brevis; thirdly, upon the insertion of the pronator teres; fourthly, upon the radial origin of the flexor sublimis; fifthly, upon the flexor longus pollicis; sixthly, upon the pronator quadratus and the lower end of the radius. The artery then crosses the wrist joint, lying upon the external lateral ligament; next, it lies upon the

trapezium; and, lastly, passing between the two heads of the first dorsal interosseous muscle, it enters the palm to form the deep palmar arch. It is accompanied by two veins, which communicate at frequent intervals, and join the venæ comites of the brachial artery at the bend of the elbow.

In the middle third of its course the artery is accompanied by the radial nerve (a branch of the musculo-spiral), which lies to its outer side. Below this point, the nerve leaves the artery, and passes, under the tendon of the supinator longus, to the back of the hand.

Thus, in the situation where the pulse is usually felt, the radial nerve no longer accompanies the artery; nevertheless, the vessel is not without a nerve, for it is accompanied by a branch of the musculo-cutaneous (or external cutaneous), which lies superficial to it.

The radial artery sends off in the forearm the following branches, besides offsets, which supply the muscles on the outer side of the forearm.

a. The *radial recurrent* is given off just below the elbow; it ascends to supply the long and short supinators and the two radial extensors. One of its ramifications runs up with the musculo-spiral nerve between the supinator longus and brachialis anticus, and forms a delicate inosculation with the superior profunda (p. 280).

b. The *arteria superficialis volæ* arises from the radial, about half an inch, or more, above the lower end of the radius: it runs over the anterior annular ligament, above, or perhaps through, the origin of the muscles of the ball of the thumb, into the palm of the hand, where it inosculates with the superficial branch of the ulnar, and completes the superficial palmar arch.*

c. The *anterior carpal* artery is a small branch of the radial, which runs beneath the tendons, and supplies the anterior surface of the synovial membrane and bones of the carpus, anastomosing with the anterior interosseous, the anterior carpal branch of the ulnar, and the recurrent carpal branch of the deep palmar arch.

* There is great variety in the size and origin of the superficialis volæ; sometimes it is very large, arises higher than usual, and runs to the wrist parallel with the radial; sometimes it is very small, terminating in the muscles of the thumb; or it may be absent.

d. The *posterior carpal* artery runs beneath the extensor tendons, and joins the corresponding branch of the ulnar to form an arch; it also anastomoses with the anterior interosseous artery on the back of the wrist.

e. Small *muscular branches* are also given off by the radial artery in its course down the forearm.

RADIAL NERVE. The radial nerve, a branch of the musculo-spiral, is given off above the bend of the elbow, deep between the supinator radii longus and brachialis anticus; it descends on the outer side of the radial artery, covered by the supinator radii longus. In the upper third of the forearm the nerve is at some distance from the artery; in the middle third it approaches nearer to it, lying to its outer side; but in the lower third, the nerve leaves the artery, passes underneath the tendon of the supinator longus, perforates the fascia on the outer side of the forearm, and becomes subcutaneous. It then divides into two branches; an *outer*, which supplies the skin of the ball of the thumb, and communicates with the musculo-cutaneous nerve; and an *inner*, which generally supplies both sides of the dorsal aspects of the thumb, of the index and middle fingers, and of the radial side of the ring finger.

ULNAR ARTERY. This artery, the larger of the two divisions of the brachial, comes off at the middle of the elbow, runs obliquely inwards along the ulnar side of the forearm to the wrist, passes over the annular ligament near the pisiform bone, and entering the palm, forms the superficial palmar arch, by inosculating with the superficialis volæ.

In the upper half of its course the artery describes a gentle curve with the concavity towards the radius, and lies deep beneath the superficial layer of muscles, namely, the pronator teres, flexor carpi radialis, palmaris longus, and flexor sublimis digitorum. It is also crossed in its upper part by the median nerve. In the lower part of its course it comes nearer the surface, and descends between the flexor sublimis and flexor carpi ulnaris, of which the tendon partially overlaps it at the wrist. The artery lies for a short distance on the brachialis anticus; in the remainder of its course it lies on the flexor profundus digitorum.

The ulnar nerve is at first separated from the artery by a considerable interval: about the middle of the forearm it joins the artery, and accompanies it in the rest of its course, lying close to its inner side. Both pass over the anterior annular ligament of the carpus, lying close to the pisiform bone,—the nerve being nearer to the bone. A strong expansion from the tendon of the flexor carpi ulnaris protects them in this exposed situation.

Observe that the ulnar artery, in the lower third of its course, lies under the radial border of the tendon of the flexor carpi ulnaris, which is the *surgical guide* to the vessel. The artery is accompanied by two veins, which join the venæ comites of the brachial.

The ulnar artery gives off the following branches in the forearm:—

a. The *anterior* and *posterior ulnar recurrent arteries* arise immediately below the elbow-joint,—sometimes by a common trunk. The *anterior* passes upwards between the brachialis anticus and the pronator teres, and inosculates with the inferior profunda and anastomotica magna. The *posterior* ascends between the flexor sublimis and the flexor profundus digitorum, to the space between the internal condyle and the olecranon: it then passes up between the two heads of the flexor carpi ulnaris, where it inosculates with the inferior profunda, the anastomotica magna, and, above the olecranon, with the posterior interosseous recurrent (p. 280).

b. The *common interosseous* artery is about half an inch long. It arises from the ulnar, just below the tubercle of the radius, and soon divides into the anterior and posterior interosseous, which we shall examine presently.

c. The *carpal branches* are given off just above the pisiform bone: the *posterior carpal* runs beneath the extensor tendons, and forms, with the corresponding branch of the radial artery, an arch, from which are usually given off the second and third dorsal interosseous arteries: these anastomose with the perforating arteries. The *anterior carpal* runs in front of the carpus, supplies the synovial membrane and the ligaments, and anastomoses with the anterior carpal from the radial.

d. Muscular branches are also distributed from the trunk of the ulnar artery in its course.

d. The *posterior carpal* artery runs beneath the extensor tendons, and joins the corresponding branch of the ulnar to form an arch; it also anastomoses with the anterior interosseous artery on the back of the wrist.

e. Small *muscular branches* are also given off by the radial artery in its course down the forearm.

RADIAL NERVE. The radial nerve, a branch of the musculo-spiral, is given off above the bend of the elbow, deep between the supinator radii longus and brachialis anticus; it descends on the outer side of the radial artery, covered by the supinator radii longus. In the upper third of the forearm the nerve is at some distance from the artery; in the middle third it approaches nearer to it, lying to its outer side; but in the lower third, the nerve leaves the artery, passes underneath the tendon of the supinator longus, perforates the fascia on the outer side of the forearm, and becomes subcutaneous. It then divides into two branches; an *outer*, which supplies the skin of the ball of the thumb, and communicates with the musculo-cutaneous nerve; and an *inner*, which generally supplies both sides of the dorsal aspects of the thumb, of the index and middle fingers, and of the radial side of the ring finger.

ULNAR ARTERY. This artery, the larger of the two divisions of the brachial, comes off at the middle of the elbow, runs obliquely inwards along the ulnar side of the forearm to the wrist, passes over the annular ligament near the pisiform bone, and entering the palm, forms the superficial palmar arch, by inosculating with the superficialis volæ.

In the upper half of its course the artery describes a gentle curve with the concavity towards the radius, and lies deep beneath the superficial layer of muscles, namely, the pronator teres, flexor carpi radialis, palmaris longus, and flexor sublimis digitorum. It is also crossed in its upper part by the median nerve. In the lower part of its course it comes nearer the surface, and descends between the flexor sublimis and flexor carpi ulnaris, of which the tendon partially overlaps it at the wrist. The artery lies for a short distance on the brachialis anticus; in the remainder of its course it lies on the flexor profundus digitorum.

The ulnar nerve is at first separated from the artery by a considerable interval: about the middle of the forearm it joins the artery, and accompanies it in the rest of its course, lying close to its inner side. Both pass over the anterior annular ligament of the carpus, lying close to the pisiform bone,—the nerve being nearer to the bone. A strong expansion from the tendon of the flexor carpi ulnaris protects them in this exposed situation.

Observe that the ulnar artery, in the lower third of its course, lies under the radial border of the tendon of the flexor carpi ulnaris, which is the *surgical guide* to the vessel. The artery is accompanied by two veins, which join the venæ comites of the brachial.

The ulnar artery gives off the following branches in the forearm:—

a. The *anterior* and *posterior ulnar recurrent arteries* arise immediately below the elbow-joint,—sometimes by a common trunk. The *anterior* passes upwards between the brachialis anticus and the pronator teres, and inosculates with the inferior profunda and anastomotica magna. The *posterior* ascends between the flexor sublimis and the flexor profundus digitorum, to the space between the internal condyle and the olecranon: it then passes up between the two heads of the flexor carpi ulnaris, where it inosculates with the inferior profunda, the anastomotica magna, and, above the olecranon, with the posterior interosseous recurrent (p. 280).

b. The *common interosseous* artery is about half an inch long. It arises from the ulnar, just below the tubercle of the radius, and soon divides into the anterior and posterior interosseous, which we shall examine presently.

c. The *carpal branches* are given off just above the pisiform bone: the *posterior carpal* runs beneath the extensor tendons, and forms, with the corresponding branch of the radial artery, an arch, from which are usually given off the second and third dorsal interosseous arteries: these anastomose with the perforating arteries. The *anterior carpal* runs in front of the carpus, supplies the synovial membrane and the ligaments, and anastomoses with the anterior carpal from the radial.

d. Muscular branches are also distributed from the trunk of the ulnar artery in its course.

ULNAR NERVE. This nerve runs behind the internal condyle, between the two origins of the flexor carpi ulnaris. In its course down the upper part of the forearm, the nerve is still covered by this muscle, and lies upon the flexor profundus digitorum. About the middle of the forearm, the nerve joins the ulnar artery, and runs along its inner side over the anterior annular ligament into the palm.

The ulnar nerve, as it lies behind the elbow, gives off some filaments to the joint. It supplies branches to the flexor carpi ulnaris, and to the ulnar half of the flexor profundus digitorum. It also gives off a small cutaneous branch, which accompanies the ulnar artery to the palm.

About two inches above the styloid process of the ulna, the nerve gives off, to the back of the hand, its *dorsal cutaneous branch*, which is of considerable size. This crosses under the tendon of the flexor carpi ulnaris, and, immediately below the styloid process of the ulna, appears on the back of the hand, where it divides into branches which supply the back of the little finger, and half the ring finger; here also it sends a branch which communicates with the corresponding branch of the radial nerve.

MEDIAN NERVE. This nerve, at the bend of the elbow, lies on the inner side of the brachial artery. It then passes between the two origins of the pronator teres, and descends along the middle of the forearm, between the flexor sublimis and the flexor profundus digitorum. At the lower part of the forearm, it becomes more superficial, lying about the middle of the wrist, between the outer tendon of the flexor sublimis, and the inner border of the tendon of the flexor carpi radialis: it then enters the palm beneath the anterior annular ligament, and divides into five branches for the supply of the thumb, both sides of the fore and middle fingers, and the outer side of the ring finger.*

Immediately below the elbow, the median nerve sends branches to the pronator teres and all the flexor muscles of the forearm,

* If the tendon of the palmaris longus happen to be broader than usual, it may partially cover the median nerve near the wrist; but most frequently the nerve is immediately beneath the fascia, the tendon lying to its ulnar side.

except the flexor carpi ulnaris and the ulnar half of the flexor profundus, which are supplied by the ulnar nerve. The anterior *interosseous* nerve, a branch of the median, runs with the anterior interosseous artery, close to the interosseous membrane, between the flexor longus pollicis and flexor profundus digitorum: it supplies both these muscles and the pronator quadratus.

Before the median nerve passes beneath the annular ligament, it sends off its *cutaneous palmar* branch, which passes over the ligament, and divides into small filaments to supply the skin of the palm and ball of the thumb, communicating with the cutaneous palmar branches of the ulnar, the external cutaneous, and the radial.

DISSECTION. Now reflect the superficial layer of muscles, to see those more deeply seated. Preserve the principal vessels and nerves.

The deep-seated muscles are the flexor digitorum profundus, and the flexor longus pollicis; beneath both, near the wrist, lies the pronator quadratus. Close to the interosseous membrane run the anterior interosseous artery and nerve.

FLEXOR PROFUNDUS DIGITORUM. This is the thickest muscle of the forearm. It *arises* from the upper two-thirds of the anterior surface of the ulna, from the same extent of its internal surface, from the aponeurosis attached to the posterior edge of the ulna, and from the inner two-thirds of the interosseous membrane. About the middle of the forearm it divides into four muscular slips, which terminate in flat tendons. These tendons lie upon the same plane, and pass beneath the annular ligament, under those of the superficial flexor, into the palm. On the first phalanx of the fingers, the tendons of the deep flexor perforate those of the superficial, and are *inserted* into the base of the third or ungual phalanx. It derives its nerves from the interosseous branch of the median and the ulnar.

FLEXOR LONGUS POLLICIS. This muscle is situated on the front surface of the radius, outside the preceding. It *arises* from the front surface of the radius, between the tubercle and the pronator quadratus, and from the interosseous membrane.* Its tendon

* Sometimes by a slip from the coronoid process.

proceeds beneath the annular ligament to the base of the last phalanx of the thumb. Its nerve comes from the interosseous branch of the median.

PRONATOR QUADRATUS. This square muscle *arises* from the lower fourth of the ulna; its fibres pass some transversely, some obliquely outwards, and are *inserted* into the lower fourth of the radius. It pronates the radius on the ulna. Its nerve proceeds from the interosseous branch of the median.

ANTERIOR INTEROSSEOUS ARTERY. Nearly on a level with the insertion of the biceps, the ulnar artery gives off from its outer side the *common interosseous*, which runs backwards for about half an inch, and divides into the *anterior* and *posterior interosseous*.

The *anterior interosseous* artery runs close to the interosseous membrane, lying between the flexor profundus digitorum and flexor longus pollicis. At the upper edge of the pronator quadratus it divides into two branches; one of which, the smaller, passes behind the muscle, supplies it and the front of the carpal bones, communicating with the anterior carpal arteries from the radial and ulnar; the other, the more important, perforates the interosseous membrane, and helps to supply the muscles on the back of the forearm.

A branch, the *arteria comes nervi mediani*, proceeds from the anterior interosseous. It lies in close contact with the nerve, sometimes in its very centre: though usually of small size, it may be as large as the ulnar artery itself, and, in such cases, it passes under the annular ligament with the nerve to join the palmar arch. This is interesting, because it helps to explain the recurrence of hæmorrhage from a wound in the palm even after the radial and ulnar arteries have been tied.

The anterior interosseous artery gives off branches to the muscles on either side, and the nutrient arteries, which enter the radius and ulna, from below upwards, near the centre of the forearm, to supply the medullary membrane.

ANTERIOR INTEROSSEOUS NERVE. This nerve is a branch of the median; it generally runs close to the radial side of the artery, and supplies the flexor longus pollicis, half the flexor profundus digitorum, and the pronator quadratus.

DISSECTION OF THE PALM OF THE HAND.

DISSECTION. Make a vertical incision along the centre of the palm, and a transverse one along the bases of the fingers; from this transverse cut continue vertical incisions along the front of the fingers, and reflect the skin; taking care not to remove a small cutaneous muscle—the palmaris brevis—situated near the ball of the little finger, and also two small cutaneous branches of the median and ulnar nerves, which are found in the fat of the palm.

Observe how closely, in the centre of the palm, the skin adheres to the palmar fascia beneath it. On the ball of the little finger and the distal ends of the metacarpal bones, the subcutaneous structure is composed of a dense filamentous tissue, which contains numerous pellets of fat, forming an elastic pad. A similar padding protects the palmar surfaces of the fingers. These cushions on the ends of the fingers defend them in the powerful actions of the hand; they are also useful in subservience to the nerves of touch.

The palm is supplied with nerves by two small branches—one, the *palmar branch* of the median, passes in front of the anterior annular ligament to the centre of the palm; the other, the *palmar branch* of the ulnar, supplies the inner aspect of the hand.

PALMARIS BREVIS. This small cutaneous muscle is situated on the inner side of the palm. It *arises* from the inner edge of the central palmar fascia, and is *inserted* into the skin on the inner side of the palm. Its use is to support the pad on the inner edge of the palm: it acts powerfully as we grasp; it raises the inner edge of the palm and deepens the hollow of it, forming the so-called 'cup of Diogenes.' It is supplied by the ulnar nerve.

PALMAR FASCIA. This fascia has a silvery lustre, and, in the centre of the palm, is remarkably dense and strong. It is divided into three portions, a central—by far the strongest; an external, covering the muscles of the thumb; and an internal, covering the muscles of the little finger. From the

deep surface of the fascia two septa dip down, and divide the palm into three separate compartments; one for the ball of the thumb, a second for that of the little finger, and a third for the centre of the palm.

The fascia is formed by a prolongation from the anterior annular ligament. It is also strengthened by the expanded tendon of the palmaris longus.

The central portion of the fascia is triangular, with the apex at the wrist. About the middle of the palm it splits into four portions, which are connected by transverse tendinous fibres, extending completely across the palm, and corresponding pretty nearly to the transverse furrow of the skin in this situation.

Examine any one of these four portions of the fascia, and you will find that it splits into two strips which embrace the corresponding flexor tendons, and are intimately connected with the transverse metacarpal ligament. The effect of this is that the flexor tendons of each finger are kept in place in the palm, by a fibrous ring. Between the four divisions of the palmar fascia the digital vessels and nerves emerge, and descend in a line with the clefts between the fingers.

In the hands of mechanics, in whom the palmar fascia is usually very strong, we find that slips of it are lost in the skin at the lower part of the palm, and also for a short distance along the sides of the fingers.

The chief use of the palmar fascia is, to protect the vessels and nerves from pressure, when anything is grasped in the hand. It also confines the flexor tendons in their proper place.

Beneath the interdigital folds of the skin, there are aponeurotic fibres to strengthen them, constituting what are called the *transverse ligaments* of the fingers. They form a continuous ligament across the lower part of the palm, in front of the digital vessels and nerves.

DISSECTION. Cut through the palmar fascia at its attachment to the anterior annular ligament, and reflect it towards the fingers, so as to expose the vessels, nerves, and tendons in the palm. The vessels lie above the nerves, and the tendons

still deeper. There is an abundance of loose connective tissue to allow the free play of the tendons. When suppuration takes place in the palm, it is seated in this tissue. Reflect for a moment what mischief is likely to ensue. The pus cannot come to the

FIG. 58.

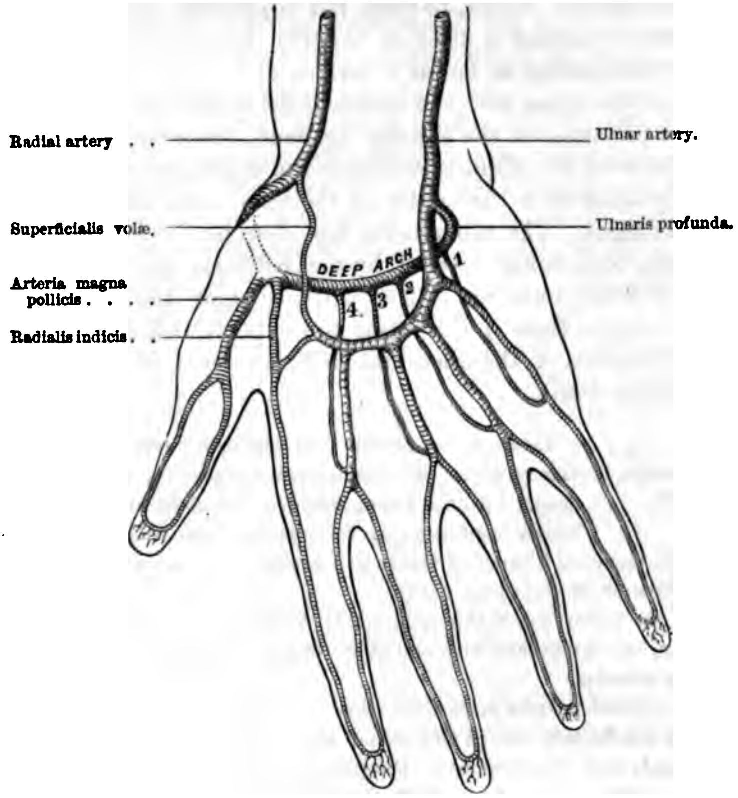

DIAGRAM OF THE SUPERFICIAL AND DEEP PALMAR ARCHES.
1, 2, 3, 4. Interosseous branches.

surface through the dense palmar fascia, or on the back of the hand; it will therefore run up into the carpal bursa under the annular ligament, and make its way deep amongst the tendons of the forearm.

SUPERFICIAL PALMAR ARCH. The ulnar artery, having passed over the annular ligament, near the pisiform bone, describes a curve across the upper part of the palm, beneath the palmar fascia, towards the thumb, and, gradually diminishing in size, inosculates with the superficialis volæ, and very commonly with a branch from the arteria radialis indicis, to form the *superficial palmar arch.* The curve of the arch is directed towards the fingers, its greatest convexity descending as low as a horizontal line drawn across the junction of the upper with the middle third of the palm.

In its passage over the annular ligament, the artery lies in the furrow, between the pisiform and unciform bones, and is protected by an expansion from the tendon of the flexor carpi ulnaris to the palmaris longus. The ulnar nerve lies close to the inner side of the artery, both being covered by the palmaris brevis. In the palm, the artery rests for a short distance upon the muscles of the little finger, then it lies upon the superficial flexor tendons and the divisions of the ulnar and median nerves; and is covered by the palmar fascia.

BRANCHES OF THE ULNAR ARTERY IN THE PALM. Immediately below the pisiform bone, the ulnar artery gives off the *ulnaris profunda,* which sinks deeply into the palm, between the abductor and flexor brevis minimi digiti, to form the deep palmar arch, by joining the terminal branch of the radial artery. It is accompanied by the deep branch of the ulnar nerve.

From the concavity of the arch small *recurrent branches* ascend to the carpus, and inosculate with the other carpal branches of the radial and ulnar arteries.

Four digital arteries arise from the convexity of the arch. They supply all the fingers, except the radial side of the index finger. The *first* descends over the muscles on the inner side of the palm, to the ulnar side of the little finger, along which it runs to the apex. The *second, third,* and *fourth* descend nearly vertically between the tendons, *in a line with the clefts* between the fingers, and, about half an inch above the clefts, each divides into two branches, which proceed along the opposite sides of the fingers nearly to the end of the last phalanges, where they unite to form an arch with the convexity towards the end of the finger; from this arch numerous branches supply the papillæ at the tip of the finger.

In the palm of the hand the digital arteries, before they divide, are joined by branches from the corresponding palmar interosseous arteries (branches of the deep palmar arch) (fig. 58).

The digital arteries freely communicate, on the palmar and dorsal aspect of the fingers, by transverse branches, which supply the joints and the sheaths of the tendons. Near the ungual phalanx, a considerable branch passes to the back of the finger, and forms a network of vessels which supply the matrix of the nail.

ULNAR NERVE IN THE PALM. The *ulnar nerve* passes over the annular ligament into the palm, on the inner side of the ulnar artery, and a little behind it. It lies in the groove between the pisiform and unciform bones, so that it is perfectly secure from pressure. Immediately below the pisiform bone, the nerve divides into a superficial and a deep palmar branch. The *deep* branch supplies the muscles forming the ball of the little finger, and accompanies the ulnaris profunda artery into the palm, to supply *all* the interosseous muscles, the two inner lumbricales, the adductor pollicis, and the inner head of the flexor brevis pollicis. The *superficial* branch sends filaments to the palmaris brevis, to the skin on the inner side of the palm, and then divides into two digital nerves, one for the supply of the ulnar side of the little finger, the other for the contiguous sides of the little and ring fingers. This branch also communicates with the median nerve behind the superficial palmar arch. All the digital branches run along the sides of the fingers to their extremities superficial to their corresponding arteries.

ANTERIOR ANNULAR LIGAMENT OF THE CARPUS. This exceedingly strong and thick ligament confines the flexor tendons of the fingers and thumb, and fastens together the bones of the carpus. It is attached, externally, to the scaphoid and trapezium; internally, to the pisiform and unciform. Its upper border is continuous with the aponeurosis in front of the wrist; its lower is connected with the palmar fascia; its anterior surface receives the expanded tendon of the palmaris longus, and gives origin to most of the muscles of the ball of the thumb and little finger.

DISSECTION. Cut vertically through the ligament, and observe that, with the carpal bones, it forms an elliptical canal, with the broad diameter transversely. This canal is lined by a synovial membrane which is reflected loosely over the tendons. Superficial to the ligament, pass the palmaris longus, the ulnar artery and nerve, and the palmar branch of the median nerve; beneath it, pass the superficial and deep flexor tendons of the fingers, the long flexor tendon of the thumb, and the median nerve. The tendon of the flexor carpi radialis does not run with the other tendons, but is contained in a distinct sheath, lined by a separate synovial membrane, formed, partly by the annular ligament, and, partly, by the groove in the trapezium.

MEDIAN NERVE IN THE PALM. In its passage under the annular ligament, the median nerve is enveloped in a fold of synovial membrane, and lies upon the flexor tendons. Here it divides into two nearly equal parts; the external gives branches to the muscles of the ball of the thumb, namely, to the abductor pollicis, the opponens pollicis, and the outer head of the flexor brevis pollicis, and then terminates in three digital nerves, two of which are distributed to the thumb, and the third to the outer side of the index finger; the internal gives digital branches which supply the inner side of the forefinger, both sides of the middle finger, and the radial side of the ring finger.

The *two* nerves to the thumb proceed, one on each side of the long flexor tendon, to the last phalanx: the outer one being connected with a terminal filament of the radial.

The *third* digital nerve runs along the radial side of the index finger. The *fourth* descends towards the cleft between the index and middle fingers, and subdivides into two branches, which supply their opposite sides. The *fifth* is joined by a filament from one of the ulnar digital nerves, and then subdivides above the cleft between the middle and ring fingers, to supply their opposite sides.

Two small branches are given off from the third and fourth digital nerves, to supply the two outer lumbricales; the two inner being supplied by the ulnar.

About an inch and a quarter above the clefts between the fingers, each digital nerve subdivides into two branches, between which the

digital artery passes and bifurcates lower down; therefore a vertical incision down the cleft would divide the artery before the nerve.

In their course along the fingers and thumb, the nerves lie superficial to the arteries, and nearer to the flexor tendons. About the middle of the first phalanx each nerve sends a branch, which runs along the back of the finger nearly to the extremity, communicating with the dorsal branches, derived from the radial and ulnar nerves.* Near the ungual phalanx another branch is distributed to the skin around and beneath the matrix of the nail. Each digital nerve terminates in the cushion at the end of the finger in a brush of filaments, with their points directed into the papillæ of the skin.

FLEXOR TENDONS AND THEIR SHEATHS. Immediately below the annular ligament the tendons separate from each other: near the metacarpal joints they pass in pairs, through strong fibrous rings (p. 298) formed by the divisions of the palmar fascia. Below the metacarpal joint the two tendons for each finger enter the sheath, *theca*, which confines them in their course along the phalanges. It is formed by a strong fibrous membrane, which is attached to the ridges on the phalanges, and converts the groove in front of these bones into a complete canal, exactly large enough to contain the tendons. The density of the sheath varies in particular situations, otherwise there would be an obstacle to the easy flexion of the fingers. To ascertain this, cut open one of the sheaths along its entire length; you will then see that it is much

* Upon the cutaneous nerves of the hand and feet are little bodies, termed, after their discoverer, corpuscles of Pacini. Some of them will be found, by carefully examining the trunk of a nerve, or one of its smaller branches, in the subcutaneous tissue at the root of a finger. Each corpuscle is about $\frac{1}{12}$ of an inch long, and is attached by a slender fibro-cellular pedicle to the nerve upon which it is situated; through the pedicle, a single primitive nerve fibril passes into the corpuscle. The corpuscle itself is composed of a series of concentric capsules, varying from twenty to fifty in number, and separated by intervals containing fluid: and the nerve fibril terminates by a dilated extremity in a central cavity, which exists in the axis of the corpuscle. Their function is unknown. These bodies are found in many other situations, viz., in the solar plexus, the pudic nerves, the intercostal nerves, the cutaneous nerves of the arm and neck, the infra-orbital nerve, the sacral plexus, and in nerves supplying the periosteum. They can be best examined in the mesentery of the cat.

stronger between the joints than over the joints themselves. Through these sheaths, inflammation commencing in the integuments of the finger may readily extend to the synovial membrane of the tendon.

In cases of whitlow, when pus forms in the theca, the incision should be made deep enough to lay open this fibro-osseous canal, without which the incision will be of no use. It is obvious that the incision should be made down the *centre* of the finger, to avoid the digital nerves and arteries. If this opening be not timely made, the flexor tendons are likely to slough, and the finger becomes stiff.*

But what protects the joints of the fingers where the flexor tendons play over them? Look into an open sheath, and you will see that in front of the joints the tendons glide over a smooth fibro-cartilaginous structure, called the '*palmar*' ligament.

To facilitate the play of the tendons, the interior of the sheath, as well as the tendons, is lined by a synovial membrane, of the extent of which it is important to have a correct knowledge. With a probe you may ascertain that the synovial membrane is reflected from the sheath upon the tendons, a little above the metacarpal joints of the fingers; that is, nearly in a line with the transverse fold in the skin in the lower third of the palm. Towards the distal end of the finger, the synovial sheath stops short of the last joint, so that it is not injured in amputation of the ungual phalanx.

And now notice how the tendons are adapted to each other in their course along the finger. The superficial flexor, near the root of the finger, becomes slightly grooved to receive the deep flexor; about the middle of the first phalanx it splits into two portions, through which the deep flexor passes. The two portions reunite

* On closer inspection it will be observed that the sheath is composed of bands of fibres, which take different directions, and have received distinct names. The strongest are called the '*ligamenta vaginalia.*' They constitute the sheath over the body of the phalanx, and extend transversely from one side of the bone to the other. The '*ligamenta cruciata*' are two slips, which cross obliquely over the tendons. The '*ligamenta annularia*' are situated immediately in front of the joints, and may be considered as thin continuations of the ligamenta vaginalia. They consist of fibres, which are attached on either side to the lateral ligaments of the joints, and pass transversely over the tendons.

below the deep tendon so as to embrace it, and then divide a second time into two slips, which interlace with each other and are inserted into the sides of the second phalanx. The *deep* flexor, having passed through the opening of the superficial one, is inserted into the base of the last phalanx.*

In what way are the tendons supplied with blood? Raise and separate the tendons, and you will see that slender but very vascular folds of synovial membrane (vincula tendinum) run up from the phalanges and convey blood-vessels to the tendons.

The *tendon of the flexor longus pollicis* lies on the radial side of the other tendons beneath the annular ligament. It passes between the two portions of the flexor brevis pollicis and the two sesamoid bones of the thumb, enters its proper sheath, and is *inserted* into the base of the last phalanx. Its synovial sheath is prolonged from the large bursa of the flexor tendons beneath the annular ligament, and accompanies the tendon down to the last joint of the thumb; consequently the sheath is injured in amputation of the last phalanx.

BURSAL SAC OF THE CARPUS. A large and loose synovial sac (bursa of the carpus) facilitates the play of the tendons beneath the anterior annular ligament. It lines the under surface of the ligament and the groove of the carpus, and is reflected in loose folds over the tendons. It is prolonged up the tendons for an inch and a half, or two inches, and forms a cul-de-sac above the ligament. Below the ligament the bursa extends into the palm, and sends off prolongations for each of the flexor tendons, which accompany them down to the middle of the hand. You will understand that, when the bursa is inflamed and distended by fluid, there will be a bulging above the annular ligament, and another in the palm, with perceptible fluctuation between them; the unyielding ligament causing a constriction in the centre.†

* In the Museum of the College of Surgeons, a preparation is put up which shows a beautiful piece of animal mechanics concerning the flexor tendons; namely, that in its passage along the phalanges, the deep flexor forms, at the first phalanx, a kind of little patella for the superficial one; but, at the second phalanx, the superficial flexor lies deeper than the other, and forms a little patella for it. This increases the leverage in each case.

† In only one subject have we seen an instance in which this bursa communicated

LUMBRICALES. These four slender muscles, one for each finger, are attached to the deep flexor tendons in the palm. All of them *arise* from the radial side of the deep tendon of their corresponding finger: the third and fourth also arise from the adjacent sides of two tendons. Each terminates in a broad thin tendon which passes over the radial side of the first joint of the finger, and is *inserted* into the extensor tendon on the dorsal aspect of the first phalanx of the finger. Their *action* is to bend the first joint of the fingers. Being inserted near the centre of motion, they can move the fingers with great rapidity. As they produce the quick motions of the musician's fingers, they were called by the old anatomists 'fidicinales.'

The two inner lumbricales are supplied by the deep branch of the ulnar nerve; the two outer by the third and fourth digital branches of the median.

Now proceed to the muscles composing the ball of the thumb and the little finger. The dissection of them requires considerable care.

MUSCLES OF THE BALL OF THE THUMB. The great strength of the muscles of the ball of the thumb (unde nomen pollicis), is one of the distinguishing features of the human hand. This strength is necessary in order to oppose that of all the fingers. In addition to its strength, the thumb enjoys perfect mobility. It has no less than eight muscles—namely, an abductor, an opponens, two flexors, three extensors, and an adductor.

ABDUCTOR POLLICIS. This is the most superficial. It is a thin, flat muscle, and *arises* from the ridge of the os trapezium and the annular ligament. It is *inserted* by a flat tendon into the base of the first phalanx of the thumb. Its *action* is to draw the thumb away from the fingers. Its nerve comes from the median. Reflect it from its insertion to expose the following:—

with the wrist joint. It communicates always with the synovial sheath of the long flexor of the thumb, in most cases with that of the flexors of the little finger, and but rarely with that of the index, middle, and ring fingers. For this reason, inflammation of the theca of the thumb or little finger is more liable to be attended with serious consequences than either of the others.

OPPONENS POLLICIS. This muscle *arises* from the os trapezium beneath the abductor, and from the annular ligament, and is *inserted* into the whole length of the radial side of the metacarpal bone of the thumb. The *action* of this powerful muscle is to oppose the thumb to all the fingers. Its nerve comes from the median. Reflect it from its insertion, to expose the following:—

FLEXOR BREVIS POLLICIS. This muscle has two origins; one, the superficial, from the annular ligament and os trapezium; the other, the deep, from the os trapezoides, os magnum, and the bases of the second and third metacarpal bones. It is *inserted* by two strong tendons into the base of the first phalanx of the thumb; the superficial tendon being connected with the abductor pollicis, and the deep one, with the adductor pollicis. A sesamoid bone is found in each of the tendons. The tendons of insertion of this muscle are separated by the long flexor tendon of the thumb and the arteria magna pollicis. Its *action* is to bend the first phalanx of the thumb. The superficial portion is supplied by the median nerve; the deep, by the ulnar.

ADDUCTOR POLLICIS. This muscle *arises* from the palmar aspect of the shaft of the metacarpal bone of the middle finger; its fibres converge and are *inserted*, along with the deep or inner portion of the flexor brevis pollicis, into the base of the first phalanx of the thumb. Its *action* is to draw the thumb towards the palm, as when we bring the tips of the thumb and little finger into contact. It is supplied by the deep branch of the ulnar nerve, which also supplies the inner head of the flexor brevis pollicis. The other muscles of the ball of the thumb are supplied by the median nerve.

MUSCLES OF THE BALL OF THE LITTLE FINGER. The muscles of the little finger correspond in some measure with those of the thumb. Thus there is an abductor, a flexor brevis, and an opponens minimi digiti. All derive their nerves from the deep branch of the ulnar.

ABDUCTOR MINIMI DIGITI. This, the most superficial of the muscles of the little finger, *arises* from the pisiform bone, and

from the tendinous expansion of the flexor carpi ulnaris: it is *inserted* by a flat tendon into the inner side of the base of the first phalanx of the little finger. Its *action* is to draw this finger from the others. Its nerve comes from the deep branch of the ulnar.

FLEXOR BREVIS MINIMI DIGITI. This slender muscle may be considered as a portion of the preceding. It *arises* from the unciform bone and annular ligament, and is *inserted* with the tendon of the abductor into the base of the first phalanx of the little finger. Its *action* is similar to that of the abductor. Nerve from deep branch of ulnar. Between the origins of the abductor and flexor brevis minimi digiti, the deep branch of the ulnar artery and nerve sinks down to form the deep palmar arch.

OPPONENS MINIMI DIGITI. The last two muscles must be reflected from their insertion, to expose the *opponens minimi digiti*. It *arises* from the unciform process and the annular ligament, and is *inserted* along the ulnar side of the shaft of the metacarpal bone of the little finger. Its *action* is to draw this bone, the most movable of all the metacarpal bones of the fingers, towards the thumb. Thus it greatly strengthens the grasp of the palm. Nerve from deep branch of ulnar.

DISSECTION. Now cut through all the flexor tendons, and remove the deep fascia of the palm, to see the deep arch of arteries and its branches.

BRANCHES OF THE RADIAL ARTERY IN THE PALM. The radial artery, sinking into the space between the first and second metacarpal bones, enters the palm between the inner head of the flexor brevis and the adductor pollicis, and gives off three branches—the arteria princeps pollicis, the radialis indicis, and the palmaris profunda, which unites with the ulnar to form the deep arch.

The *arteria princeps pollicis* runs in front of the abductor indicis (first dorsal interosseous), close along the metacarpal bone of the thumb: in the interval between the lower portions of the flexor brevis pollicis, the artery divides into two digital branches, which proceed one on either side of the thumb, and inosculate at the apex of the last phalanx. Their

distribution and mode of termination are like those of the other digital arteries.

The *arteria radialis indicis* runs between the abductor indicis and adductor pollicis, along the radial side of the index finger to the end, where it forms an arch with the other digital artery, a branch of the ulnar. Near the lower margin of the adductor pollicis, the radialis indicis generally receives a branch from the superficial palmar arch.

The *palmaris profunda* may be considered as the continuation of the radial artery. It enters the palm between the inner head of the flexor brevis and the adductor pollicis, and, running upon the bases of the metacarpal bones, inosculates with the deep branch of the ulnar artery, thus completing the *deep palmar arch.* From the curve of the arch small recurrent branches ascend to supply the bones and joints of the carpus, inosculating with the other carpal arteries.

From the convexity of the arch three or four small branches, called *palmar interosseous* (fig. 58, p. 299), descend to supply the interosseous muscles, and near the clefts of the fingers communicate with the digital arteries. These palmar interosseous branches are sometimes of considerable size, and take the place of one or more of the digital arteries, ordinarily derived from the superficial palmar arch. Three branches, called *perforating*, pass between the upper ends of the metacarpal bones to the back of the hand, and communicate with the carpal branches of the radial and ulnar.

DEEP BRANCH OF THE ULNAR NERVE. This nerve sinks into the palm with the ulnaris profunda artery, between the abductor and flexor brevis minimi digiti. It then runs with the deep palmar arch towards the radial side of the palm, and terminates in the adductor pollicis, and the inner or deep head of the flexor brevis pollicis. Between the pisiform and unciform bones, the nerve gives a branch to each of the muscles of the little finger. Subsequently it sends branches to each interosseous muscle and to the two inner lumbricales.

The tendon of the flexor carpi radialis in the palm must now be followed to its insertion into the base of the second metacarpal bone.

The dissection of the remaining muscles of the palm, called, from their position, *interossei*, must be, for the present, postponed.

MUSCLES OF THE BACK CONNECTED WITH THE ARM.

DISSECTION. Make an incision down the spine from the occiput to the sacrum; another, from the last dorsal vertebra upwards and outwards to the acromion; and a third, from the sacrum along the crest of the ilium; then reflect the skin outwards from the dense subcutaneous tissue, in which will be found the following cutaneous nerves.

CUTANEOUS NERVES OF THE BACK. These are derived from the posterior divisions of the spinal nerves, and correspond, generally, to the number of the vertebræ. The posterior primary branches, much smaller than the anterior, divide, between the transverse processes, into external and internal branches. From the *internal*, which become superficial near the spines of the vertebra, are derived those branches which supply the skin in the cervical and upper dorsal regions; from the *external*, which appear near the angles of the ribs, are derived those which supply the skin of the lower dorsal and lumbar regions. In the cervical and upper dorsal region, the cutaneous nerves perforate the complexus, splenius, and trapezius; in the lower dorsal and lumbar region, they perforate the serratus posticus inferior and latissimus dorsi. As might be expected, the external branches are the larger, especially in the loins, where some of them descend over the crest of the ilium, and terminate in the skin of the buttock.

Among these cutaneous nerves, notice, at this stage of the dissection, the following:—

1. The posterior branch of the *second cervical* nerve is called the *great occipital*. It perforates the complexus, and ramifies on the back of the scalp with the occipital artery.

2. The posterior branch of the *third cervical* nerve sometimes sends a branch to the back of the scalp.

3. The posterior branch of the *second dorsal* nerve is the largest of all the dorsal cutaneous nerves. It runs outwards and ramifies in the skin over the spine of the scapula.

4. The posterior branch of the *second lumbar* nerve comes through the fascia lumborum near the posterior superior spine of the ilium, and runs over the crest of that bone to supply the skin of the buttock.

DISSECTION. The trapezius and latissimus dorsi, which form the first layer of muscles, must now be cleaned by dissecting in the course of their fibres.

TRAPEZIUS. Alone, this muscle is triangular; with its fellow, it presents a trapezoid form. It *arises* from the inner fourth, more or less, of the superior curved line of the occiput; from the ligamentum nuchæ,* from the spines of the seventh cervical, and all the dorsal vertebræ, and from their supra-spinous ligaments. The fibres converge towards the shoulder. The upper are *inserted* fleshy into the external third of the clavicle; the middle, into the inner border of the acromion and spine of the scapula; the lower terminate in a thin tendon, which plays over the triangular surface at the back of the scapula, and is *inserted* into the beginning of the spine. The insertion of the trapezius exactly corresponds to the origin of the deltoid, and the two muscles are connected by a thin aponeurosis over the spine and acromion. If both the trapezius muscles be exposed, observe that, between the sixth cervical and the third dorsal vertebræ, their origin presents an aponeurotic space of an elliptical form.

The structures covered by the trapezius are, the splenius, the complexus, the levator anguli scapulæ, the rhomboidei minor and major, the supra-spinatus, a small part of the infra-spinatus, the longissimus dorsi, the sacro-lumbalis, the spinal accessory nerve, and the superficialis colli artery.

* The ligamentum nuchæ is, in man, only a rudiment of the great elastic ligament which supports the weight of the head in quadrupeds. It extends from the spine of the occiput to the spines of all the cervical vertebræ, except the atlas; otherwise it would impede the free rotation of the head. In the giraffe this ligament is six feet long, and as thick as a man's forearm. Professor Quekett states that when divided it shrinks at least two feet.

The fixed point of the muscle being at the vertebral column, all its fibres tend to raise the shoulder. The deltoid cannot raise the humerus beyond an angle of ninety degrees: beyond this, the elevation of the arm is principally effected by the rotatory movement of the scapula. The trapezius is in strong action when a weight is borne upon the shoulders; again, its middle and inferior fibres act powerfully in drawing the scapula backwards, as in preparing to strike a blow. If both muscles act, they draw the head backwards; if one only acts, it draws the head to the same side. It is supplied by the nervus accessorius and the cervical plexus, and by the superficialis colli artery.

LATISSIMUS DORSI. This broad flat muscle occupies the lumbar and lower dorsal region, and thence extends to the arm, where it forms part of the posterior boundary of the axilla. It *arises* from the posterior third of the external lip of the crest of the ilium, from the spinous processes of the two upper sacral, all the lumbar and the six lower dorsal vertebræ, by a strong aponeurosis; and, lastly, from the three or four lower ribs by fleshy slips, which interdigitate with those of the external oblique muscle of the abdomen. All the fibres converge towards the axilla, where they form a thick muscle, which curves round the inferior angle of the scapula, and is *inserted* by a broad, flat tendon, into the bottom of the bicipital groove of the humerus. The tendon is about two inches broad, and lies in front of and higher than that of the teres major, from which it is separated by a large *bursa.** It is supplied mainly by the long subscapular nerve, also by the posterior branches of the dorsal and lumbar nerves.

The latissimus dorsi draws the humerus inwards and backwards; rotating it also inwards. It co-operates with the pectoralis major in pulling any object towards the body: if the humerus be the fixed point, it raises the body, as in climbing. The object of the muscle arising so high up the back is, that the transverse fibres of the muscle may strap down the inferior angle of the scapula. It sometimes happens that the scapula slips above the

* The latissimus dorsi frequently receives a distinct accessory slip from the inferior angle of the scapula.

muscle: this displacement is readily recognised by the unnatural projection of the lower angle of the bone, and the impaired movements of the arm.*

The muscles lying beneath the latissimus dorsi are,—a small part of the rhomboideus major, of the infra-spinatus, and of the teres major, the serratus posticus inferior, the spinalis dorsi, the longissimus dorsi, the sacro-lumbalis, and the external intercostals. Between the base of the scapula, the trapezius, and the upper border of the latissimus dorsi, a triangular space is observed when the arm is raised, in which the lower fibres of the rhomboideus major and part of the sixth intercostal space, are exposed. Immediately above the crest of the ilium, between the free margins of the latissimus dorsi and external oblique, there is, also, an interval in which a little of the internal oblique can be seen.

LUMBAR APONEUROSIS. This dense shining aponeurosis of the back (sometimes termed the aponeurosis of the latissimus dorsi) forms the posterior part of the sheath of the erector spinæ. It is pointed above, where it is continuous with the deep cervical fascia, broader and stronger below. It consists of tendinous fibres, which are attached internally to the spines of the six or seven lower dorsal, all the lumbar and sacral vertebræ; externally, to the angles of the ribs; and inferiorly it is blended with the tendons of the serratus posticus inferior and latissimus dorsi. When suppuration takes place in the loins, constituting a lumbar abscess in connection with spinal disease, the pus is seated beneath this aponeurosis, and is therefore tardy in coming to the surface.

DISSECTION. Reflect the trapezius from its insertion. On its under surface see the ramifications of its nutrient artery, the *superficialis colli*, a branch of the posterior scapular. A large nerve, the *spinal accessory*, enters its under surface near

* We have seen several instances of this displacement. There is great projection of the inferior angle of the scapula, especially when the patient attempts to raise the arm. He cannot raise the arm beyond a right angle, unless firm pressure is made on the lower angle of the scapula, so as to supply the place of the muscular strap. Whether the scapula can be replaced or not, a firm bandage should be applied round the chest.

the clavicle, and divides into filaments, which, reinforced by filaments from the third and fourth cervical nerves, are distributed to the muscle as far as its lower border.

SPINAL ACCESSORY NERVE. This nerve is one of the three divisions of the eighth pair of cerebral nerves. It arises from the lateral part of the cervical portion of the spinal cord by several roots, some of which are as low as the sixth cervical vertebra. Formed by the union of these roots, the nerve enters the skull through the foramen magnum, and leaves it again through the foramen jugulare. It then runs behind the internal jugular vein, traverses obliquely the upper third of the sterno-mastoid, and crosses the posterior triangle of the neck to the trapezius, which it supplies (p. 19).

Beneath the trapezius we have to examine the second layer, consisting of three muscles connected with the scapula; namely, the levator anguli scapulæ, the rhomboideus major and minor. The scapula should be adjusted so as to stretch their fibres.

LEVATOR ANGULI SCAPULÆ. This muscle is situated at the side of the neck. It *arises* by four tendons from the posterior tubercles of the transverse processes of the four upper cervical vertebræ. The muscular slips to which the tendons give rise form a single muscle, which descends along the side of the neck, and is *inserted* into the posterior border of the scapula between its spine and superior angle. Its *action* is to raise the posterior angle of the scapula; as, for instance, in shrugging the shoulders. Its nerve comes from the fifth cervical.

RHOMBOIDEUS MAJOR AND MINOR. These flat muscles extend from the spinous processes of the vertebræ to the base of the scapula. They often appear like a single muscle. The rhomboideus minor, the higher of the two, *arises* by a thin aponeurosis from the spinous processes of the last cervical and the first dorsal vertebra, and is *inserted* into the base of the scapula opposite its spine. The rhomboideus major *arises* by tendinous fibres from the spinous processes of the four or five upper dorsal vertebræ, and is *inserted* by fleshy fibres into the base of the scapula between its spine and inferior angle; the larger number of the fibres being

inserted into a tendinous arch, which is chiefly attached to the inferior angle. The *action* of these muscles is to draw the scapula upwards and backwards. They are the antagonists of the serratus magnus.

The *nerve of the rhomboid muscles* (posterior scapular) is a branch of the fifth cervical. It passes outwards beneath the lower part of the levator anguli scapulæ, to which it sends a branch, and is lost in the under surface of the rhomboidei.

OMO-HYOIDEUS. This muscle extends from the scapula to the os hyoides, and consists of two long narrow muscular portions, connected by an intermediate tendon beneath the sterno-mastoid. The posterior portion only can be seen in the present dissection. It *arises* from the upper border of the scapula, close behind the notch, and from the ligament above the notch. Thence the slender muscle passes forwards across the lower part of the neck, beneath the sterno-mastoid, where it changes its direction and ascends nearly vertically, to be attached to the os hyoides at the junction of the body with the greater cornu (p. 29). Thus the two portions of the muscle form, beneath the sterno-mastoid, an obtuse angle, of which the apex is tendinous, and of which the angular direction is maintained by a layer of fascia, proceeding from the tendon to the first rib and the clavicle. Its *action* is to depress the os hyoides. Its nerve comes from the descendens noni (p. 30).

SUPRA-SCAPULAR ARTERY. This artery (transversalis humeri), a branch of the thyroid axis (p. 67), runs behind and parallel with the clavicle, over the lower end of the scalenus anticus to the upper border of the scapula, where it usually passes above the ligament bridging over the notch. It ramifies in the supra-spinous fossa, supplying the supra-spinatus, and then passes under the acromion to the infra-spinous fossa, where it inosculates freely with the dorsalis scapulæ, a branch of the subscapular. It sends off—

a. The *supra-acromial* branch, which ramifies upon the acromion, anastomosing with the other acromial arteries derived from branches of the axillary; *b.* a small *subscapular* branch to the fossa of the same

name; *c. articular* arteries to the shoulder joint; and, lastly, *d.* the *infra-spinous* branch, which anastomoses with the dorsalis scapulæ. The supra-scapular vein terminates either in the subclavian or in the external jugular.

The *supra-scapular* nerve, a branch of the fifth, and sometimes the sixth, cervical, runs with the corresponding artery, and after passing through the supra-scapular notch, is distributed to the supra-spinatus and infra-spinatus. In the supra-spinous fossa, this nerve sends a small branch to the shoulder-joint.

POSTERIOR SCAPULAR ARTERY. This artery is one of the divisions of the transversalis colli, but comes very frequently from the subclavian in the third part of its course (p. 67). It runs across the lower part of the neck, above, or between the nerves of the brachial plexus, towards the posterior superior angle of the scapula. Here it pursues its course along the posterior border of the scapula beneath the levator anguli scapulæ and the rhomboidei, anastomosing with branches of the supra-scapular and sub-scapular arteries. The corresponding vein joins the external jugular or the subclavian.

DISSECTION. Divide the rhomboid muscles near their insertion, and trace the artery to the inferior angle of the scapula, where it terminates in the rhomboidei, serratus magnus, and latissimus dorsi.

Numerous muscular branches arise from the posterior scapular. The *superficialis colli* (the other division of the transversalis colli) is given off near the upper angle of the scapula for the supply of the trapezius.

Divide and reflect the latissimus dorsi below the inferior angle of the scapula, and draw the scapula forcibly outwards, to have a more perfect view of the extent of the serratus magnus, than was seen in the axilla. The abundance of connective tissue in this situation is necessary for the play of the scapula on the chest.

SERRATUS MAGNUS. This broad flat muscle intervenes between the scapula and the ribs. It *arises* by nine fleshy digitations from the eight upper ribs, each rib giving origin to one, and the second to two. The four lower digitations correspond with

those of the external oblique muscle of the abdomen. All the fibres pass backwards, and converge to be *inserted* along the inner side of the posterior border of the scapula, chiefly near the upper and lower angles.

This is the most important of the muscles which regulate the movements of the scapula. It draws the scapula forwards, and thus gives additional reach to the arm; it counteracts all forces which tend to push the scapula backwards; for instance, when a man falls forwards upon his hands, the serratus magnus sustains the shock, and prevents the scapula from being driven back to the spine. Supposing the fixed point to be at the scapula, some anatomists ascribe to it the power of raising the ribs; hence Sir Charles Bell called it the external respiratory muscle, the internal respiratory muscle being the diaphragm.

The nerve which supplies it is a branch of the fifth and sixth cervical nerve: it descends along its outer surface, distributing a filament to each digitation of the muscle (p. 271).

DISSECTION. Divide the serratus magnus near the scapula, and remove the arm by sawing through the middle of the clavicle, cutting through the axillary vessels and nerves. These should be tied to the coracoid process. After the removal of the arm, examine the precise insertions of the preceding muscles.

DISSECTION OF THE MUSCLES OF THE SHOULDER.

DISSECTION. CUTANEOUS NERVES OF THE SHOULDER. Dissect first the cutaneous nerves of the shoulder; these are derived, partly from the acromial branches of the cervical plexus which descend over the acromion (fig. 59), partly from the circumflex nerve, of which one or two branches turn round the posterior border of the deltoid; others perforate the muscle, each accompanied by a small artery.

Notice the strong layer of fascia upon the surface of the deltoid, which extends from the aponeurosis covering the muscles

on the back of the scapula, and is continuous with the fascia of the arm. It dips down between the fibres of the muscle, dividing it into large bundles. This fascia must be removed.

DELTOID. The large muscle which covers the shoulder-joint is named deltoid, from its resemblance to the Greek Δ reversed. It *arises* from the external third of the clavicle, from the acromion, and from the spine of the scapula

FIG. 59.

1. Supra-acromial br. of the cervical nerves.
2. Ascending and descending brs. of the circumflex n.
3, 4. Cutaneous brs. of the musculo-cutaneous n.
5. Internal cutaneous br. of musculo-spiral n.
6. Intercosto-humeral brs.
7. Filaments of the lesser internal cutaneous n.
8. Posterior cutaneous br. of internal cutaneous n.
9. Branch of internal cutaneous n.

CUTANEOUS NERVES OF THE LEFT SHOULDER AND ARM. (POSTERIOR VIEW.)

down to the triangular surface at its root. This origin, which corresponds to the insertion of the trapezius, is tendinous and fleshy everywhere, except at the commencement of the spine of the scapula, where it is simply tendinous, and connected with the infra-spinous aponeurosis. The muscular fibres descend, the anterior backwards, the posterior forwards, the middle perpendicularly; all converge to a tendon which is *inserted* into a rough

surface on the outer side of the humerus, a little above the middle of the shaft. The insertion of the tendon extends one inch and a half along the humerus, and terminates in a V-shaped form, the origin of the brachialis anticus embracing it on either side. Sometimes a few fibres of the pectoralis major are connected with its front border.

The muscular bundles composing the deltoid have a peculiar arrangement: a peculiarity arising from its broad origin and its narrow insertion. It consists in the interposition of tendons between the bundles for the attachment of the muscular fibres. The annexed woodcut shows this arrangement better than any description. The action of the muscle is not only concentrated upon one point, but its power is also greatly increased by this arrangement.

ACTION OF THE DELTOID.

It raises the arm; but it cannot do so beyond an angle of ninety degrees. The elevation of the arm beyond this angle is effected through the raising of the shoulder by the trapezius and serratus magnus. Its anterior fibres draw the arm forwards; its posterior, backwards.

Fig. 60.

ANALYSIS OF THE DELTOID.

This powerful muscle is supplied with blood, by the anterior and posterior circumflex, the thoracica humeraria, the thoracica acromialis, all from the axillary artery; also by the deltoid branch of the brachial. Its nerve is the circumflex.

The rotundity of the shoulder is due not so much to the deltoid as to the upper end of the humerus. When the head of the humerus is dislocated into the axilla, the fibres of the muscle run vertically to their insertion; hence the flattening of the deltoid, and the greater prominence of the acromion.

It is below the deltoid that an ununited fracture of the humerus is most commonly met with, owing to the muscle displacing the upper fragment.

DISSECTION. Reflect the deltoid from its origin, and turn it downwards. Observe the ramifications of the circumflex nerve and the anterior and posterior circumflex arteries, on its under surface: notice also the large bursa between it and the tendons inserted into the great tuberosity of the humerus. The muscle covers the coraco-acromial ligament, the head, neck, and upper part of the humerus, as well as the coraco-brachialis and biceps, the pectoralis minor, the supra-spinatus, the infra-spinatus, and teres minor, the subscapularis and the long head of the triceps.

BURSA UNDER THE DELTOID, OR SUB-ACROMIAL. The large bursa under the deltoid extends for some distance beneath the acromion and the coraco-acromial ligament, and covers the tendons attached to the great tuberosity of the humerus. It communicates, very rarely, with the shoulder-joint. Its use is to facilitate the movements of the head of the bone under the acromial arch.

POSTERIOR CIRCUMFLEX ARTERY. This artery is given off from the axillary: it runs behind the surgical neck of the humerus, through a quadrilateral opening, bounded above by the subscapularis and teres minor, below by the teres major, externally by the neck of the humerus, and internally by the long head of the triceps (p. 266). Its branches terminate on the under surface of the deltoid, anastomosing with the anterior circumflex, acromial thoracic, and supra-scapular arteries.

From the posterior circumflex, a branch descends in the substance of the long head of the triceps, to inosculate with the superior profunda; this is one of the channels through which the circulation would be carried on, if the axillary were tied in the last part of its course.

CIRCUMFLEX NERVE. This nerve, a branch of the posterior cord of the axillary plexus, runs with the posterior circumflex artery. It sends a branch to the teres minor, one or two to the integuments of the shoulder, and terminates in the substance of

the deltoid. The proximity of this nerve to the head of the humerus explains the occasional paralysis of the deltoid, after dislocation or fracture of the humerus. The nerve is liable to be injured, if not actually lacerated, by the pressure of the bone. In the summer of 1840, a man was admitted into the hospital with a severe injury to the shoulder, and died of delirium tremens. On examination the humerus was found broken high up, the capsule of the joint opened, and the circumflex nerve torn completely across.*

A strong aponeurosis covers the muscles of the dorsum of the scapula, and is firmly attached to the spine and borders of the bone. At the posterior edge of the deltoid, it divides into two layers, one of which passes over, the other under, the muscle. Remove the aponeurosis, so far as it can be done without injury to the muscular fibres which arise from its under surface.

INFRA-SPINATUS. This muscle *arises* from the posterior two-thirds of the infra-spinous fossa, and from the aponeurosis which covers it. The fibres converge to a tendon, which is at first contained in the substance of the muscle, and then proceeds over the capsule of the shoulder-joint to be *inserted* into the middle depression on the greater tuberosity of the humerus. Its nerve comes from the supra-scapular.

TERES MINOR. This long narrow muscle is situated below the infra-spinatus, along the inferior border of the scapula. It *arises* from the dorsum of the scapula, close to the inferior border, and from the intermuscular septa between it and the infra-spinatus above and the teres major below. The fibres ascend parallel with those of the infra-spinatus, and terminate in a tendon, which passes over the capsule of the shoulder-joint, and is *inserted* into the lowest depression on the great tuberosity of the humerus, and by muscular fibres into the bone below it. It is supplied by a branch of the circumflex nerve, which has (usually) a small ganglion-like enlargement upon it.

The *action* of the infra-spinatus and teres minor is to rotate the humerus outwards.

* See preparation in Museum of St. Bartholomew's Hospital, series 3, No. 42.

TERES MAJOR. This muscle is closely connected with the latissimus dorsi, and extends from the inferior angle of the scapula to the humerus, contributing to form the posterior boundary of the axilla. It *arises* from the flat surface at the inferior angle of the back of the scapula, from its inferior border, and the intermuscular septa, and terminates upon a flat tendon, nearly two inches in breadth, which is *inserted* into the inner edge of the bicipital groove of the humerus, behind and a little lower than the tendon of the latissimus dorsi. Its *action* is to draw the humerus backwards. It is supplied by the middle subscapular nerve.

A bursa is found in front of, and another behind the tendon of the teres major; the former separates it from the latissimus dorsi, the latter from the bone.

SUPRA-SPINATUS. This muscle *arises* from the posterior two-thirds of the supra-spinous fossa, and from its aponeurotic covering. It passes under the acromion, over the shoulder-joint, and is *inserted* by a strong tendon into the superior depression of the greater tuberosity of the humerus. To see its insertion, the acromion should be sawn off near the neck of the scapula. Its *action* is to assist the deltoid in raising the arm. Its nerve is derived from the supra-scapular.

SUBSCAPULARIS. This muscle occupies the subscapular fossa. It *arises* from the posterior three-fourths of the fossa, and from three or four tendinous septa attached to the oblique bony ridges on its surface. The fibres converge towards the neck of the scapula, where they terminate upon three or four tendons, which are concealed amongst the muscular fibres, and are *inserted* into the lesser tuberosity of the humerus. Its broad insertion is closely connected with the capsule of the shoulder-joint, which it completely protects upon its inner side. Its *action* is to rotate the humerus inwards. The nerves which supply it come from the long and middle subscapular nerves.

The coracoid process, with the coraco-brachialis and short head of the biceps, forms an arch, under which the tendon of the subscapularis plays. There are several *bursæ* about the tendon.

One, of considerable size, on the upper surface of the tendon, facilitates its motion beneath the coracoid process and the coraco-brachialis: this sometimes communicates with the large bursa under the deltoid. Another is situated between the tendon and the capsule of the joint, and almost invariably communicates with it.

DISSECTION. Now reflect the muscles from the surfaces of the scapula, to trace the arteries which ramify upon it.

CONTINUATION OF SUPRA-SCAPULAR ARTERY AND NERVE. This artery, a branch of the thyroid axis, runs under and parallel with the clavicle, and passes above the notch of the scapula, into the supra-spinous fossa: it sends a branch to the supra-spinatus, another to the shoulder-joint, and then descends behind the neck of the scapula into the fossa below the spine, where it inosculates directly with the dorsalis scapulæ. Its branches ramify upon the bone, and supply the infra-spinatus and teres minor.

The supra-scapular nerve passes most frequently through the notch of the scapula, accompanies the corresponding artery, supplies the supra-spinatus with two branches, and then enters the infra-spinous fossa, to terminate in the infra-spinatus.

DORSALIS SCAPULÆ ARTERY. This artery, after passing through the triangular space (p. 266), curves round the inferior border of the scapula, which it grooves, to the infra-spinous fossa, where it ascends close to the bone, and anastomoses with the supra and posterior scapular arteries.

The several communications about the scapula between the branches of the subclavian and axillary arteries, would furnish a large collateral supply of blood to the arm, if the subclavian were tied above the clavicle (p. 69).

TRICEPS EXTENSOR CUBITI. This muscle, which arises by three heads, and was only partially seen in the dissection of the upper arm (p. 284), should now be thoroughly examined. The *long head arises* immediately below the glenoid cavity of the scapula, by a strong tendon, which is connected with the capsule of the shoulder-joint. The *external head arises* from the posterior part of the humerus, below the insertion of the teres

minor, as far as the musculo-spiral groove. The *internal head arises* from the posterior part of the humerus, below the teres major and the musculo-spiral groove, as far as the olecranon fossa; it has an additional origin from the internal intermuscular septum, and from a small portion of the external. The precise origin of these heads from the humerus, may be ascertained by following the superior profunda artery and musculo-spiral nerve, which separate them. The three portions of the muscle terminate upon a broad tendon, which covers the back of the elbow-joint, and is *inserted* into the summit and sides of the olecranon; it is also connected with the fascia on the back of the forearm. The effect of this connection is that the same muscle which extends the forearm tightens the fascia which gives origin to the extensors of the wrist and fingers. The same holds good in the case of the biceps, and its semi-lunar expansion in the fascia of the forearm.

Between the tendon and the olecranon is a *bursa*, commonly of small size, but sometimes so large as to extend upwards behind the capsule of the joint. This bursa must not be mistaken for the subcutaneous one, which is situated between the skin and the olecranon, and is so often injured by a fall on the elbow.

DISSECTION. By dividing the triceps transversely a little above the elbow, and turning down the lower portion, it will be seen that some of the muscular fibres terminate upon the capsule of the joint. They have been described by some anatomists as a distinct muscle, under the name of *sub-anconeus*; their use is to draw up the capsule, so that it may not be injured during extension of the arm. The sub-anconeus is in this respect analogous to the sub-cruræus muscle of the thigh. Observe the *bursa* under the tendon, and the arterial arch formed upon the back part of the capsule by the superior profunda and the anastomotica magna (fig. 61, p. 334).

Trace the continuation of the superior profunda artery (p. 279) and musculo-spiral nerve round the posterior part of the humerus. They lie in a slight groove on the bone,* between the external

* It is worth remembering that the nerve may be injured by a fracture of the humerus in this situation, and even by too tight bandaging; the result being paralysis of the extensor muscles of the forearm.

and internal heads of the triceps, and are protected by an aponeurotic arch, thrown over them by the external head of the triceps. After supplying the muscles, the artery continues its course along the outer side of the arm between the brachialis anticus and supinator radii longus, and inosculates with the radial recurrent. It gives off a branch, which runs down between the triceps and the bone, and inosculates, at the back of the elbow, with the anastomotica magna and posterior interosseous recurrent. The musculo-spiral nerve which accompanies the artery sends branches to supply the three portions of the triceps, the supinator radii longus, and extensor carpi radialis longior.* It then divides into the posterior interosseous and radial nerves. The small nerve must be made out which runs down the substance of the triceps, accompanied by a branch from the superior profunda artery, to supply the anconeus. The cutaneous branches of the musculo-spiral nerve have been already dissected (p. 272).

DISSECTION OF THE BACK OF THE FOREARM.

SUBCUTANEOUS BURSÆ.

Remove the skin from the back of the forearm, hand, and fingers, and make out the subcutaneous *bursa* over the olecranon. It is of considerable size, and, if distended, would appear nearly as large as a walnut. Another *bursa* is sometimes found a little lower down upon the ulna. A subcutaneous *bursa* is generally placed over the internal condyle, another over the external. A *bursa* is also situated over the styloid process of the ulna; this sometimes communicates with the sheath of the extensor carpi ulnaris. Small *bursæ* are sometimes developed in the cellular tissue over each of the knuckles.

The cutaneous veins, from the back of the hand and forearm, join the venous plexus at the bend of the elbow (see p. 273).

CUTANEOUS NERVES OF THE BACK OF THE FOREARM.

The cutaneous nerves of the back of the forearm, are derived from the external cutaneous branches of the musculo-spiral, from branches of the internal cutaneous, and of the external cuta-

* The brachialis anticus usually receives a branch from the musculo-spiral nerve.

neous. The greater number of these nerves may be traced down to the back of the wrist.

NERVES ON THE BACK OF THE HAND AND FINGERS. The skin on the back of the hand is united to the subjacent tendons by an abundance of loose connective tissue, in which are large veins, and branches of the radial and ulnar nerves. The *dorsal branch* of the ulnar nerve passes beneath the tendon of the flexor carpi ulnaris, over the internal lateral ligament of the wrist, and divides upon the back of the hand into filaments, which supply both sides of the back of the little finger, the ring finger, and the ulnar side of the middle finger. The *radial nerve* passes obliquely beneath the tendon of the supinator longus, and subdivides into filaments, which supply both sides of the back of the thumb and forefinger, and the radial side of the middle finger.*

The radial nerve commonly gives off, on the back of the hand, a branch which joins the nearest branch of the ulnar.

FASCIA ON BACK OF FOREARM. The fascia on the back of the forearm is composed of fibres interlacing and stronger than that upon the front of the forearm. It is attached to the condyles of the humerus and to the olecranon, and is strengthened by an expansion from the tendon of the triceps. Along the forearm it is attached to the ridge on the posterior part of the ulna. Its upper third gives origin to the fibres of the muscles beneath it, and divides them by septa, to which their fibres are also attached.

POSTERIOR ANNULAR LIGAMENT. This ligament should be considered as a part of the fascia of the forearm, specially strengthened by oblique aponeurotic fibres on the back of the wrist, to confine the extensor tendons. These fibres are attached

* The relative share which the radial and ulnar nerves take in supplying the fingers varies. Under any arrangement the thumb and each finger has two dorsal nerves, one on either side, of which the terminal branches reach the root of the nail. They supply filaments to the skin on the back of the finger, and have frequent communications with the palmar digital nerves. In some instances, one or more of the dorsal nerves do not extend beyond the first phalanx; their place is then supplied by a branch from the palmar nerve.

to the styloid process of the radius, and thence pass obliquely inwards to the inner side of the wrist, where they are connected with the pisiform and cuneiform bones. They pass below the styloid process of the ulna, to which they are in no way attached, otherwise the rotation of the radius would be impeded.

SEPARATE SHEATHS FOR EXTENSOR TENDONS.

From the deep surface of the posterior annular ligament, processes are attached to the ridges on the back of the radius so as to form six distinct sheaths for the passage of the extensor tendons. Commencing from the radius, the first sheath contains the tendons of the extensor ossis metacarpi and the extensor primi internodii pollicis; the second, the tendons of the extensor carpi radialis longior and brevior; the third, the tendon of the extensor secundi internodii pollicis; the fourth the tendons of the indicator and the extensor communis digitorum; the fifth, the tendon of the extensor minimi digiti; and the sixth, the tendon of the extensor carpi ulnaris. All the sheaths are lined by synovial membranes, which extend nearly to the insertions of their tendons. Occasionally, but not often, one or more of them communicate with the wrist-joint.

The *fascia of the metacarpus* consists of a thin fibrous layer, continued from the posterior annular ligament. It separates the extensor tendons from the subcutaneous veins and nerves, and is attached to the radial side of the second metacarpal bone, and the ulnar side of the fifth.

DISSECTION.

The fascia must be removed from the muscles, without injuring the muscular fibres which arise from its under surface. Preserve the posterior annular ligament. The following superficial muscles are now exposed, and should be examined in the order in which they are placed, proceeding from the radial to the ulnar side:—1. The supinator radii longus (already described, p. 290). 2. The extensor carpi radialis longior. 3. The extensor carpi radialis brevior. 4. The extensor communis digitorum. 5. The extensor minimi digiti. 6. The extensor carpi ulnaris. 7. The anconeus.

SUPERFICIAL MUSCLES ON THE BACK OF THE FOREARM.

A little below the middle of the forearm, the extensors of the wrist and fingers diverge from each other, leaving an interval, in which are seen the three extensors of the thumb—namely, the extensor ossis metacarpi pollicis, the extensor primi internodii pollicis, and the extensor secundi internodii pollicis. The two former cross the radial extensors of the wrist, and pass over the lower third of the radius.

Between the second and third extensors of the thumb, we observe a part of the lower end of the radius, which is not covered either by muscle or tendon. This subcutaneous portion of the bone is immediately above the prominent tubercle in the middle of its lower extremity, and, since it can be easily felt through the skin, it presents a convenient place for examination in doubtful cases of fracture.

EXTENSOR CARPI RADIALIS LONGIOR. This muscle is partly covered by the supinator radii longus. It *arises* from the lower third of the ridge leading to the external condyle of the humerus, and from the intermuscular septum. It descends along the outer side of the forearm, and terminates about the middle, in a flat tendon, which passes beneath the extensor ossis metacarpi and primi internodii pollicis, traverses a groove on the outer and back part of the radius, lined by a synovial membrane, and is *inserted* into the radial side of the carpal end of the metacarpal bone of the index finger. Previous to its insertion, the tendon is crossed by the extensor secundi internodii pollicis. It is supplied by a branch from the musculo-spiral nerve.

EXTENSOR CARPI RADIALIS BREVIOR. This muscle *arises* from the external condyle by the tendon common to it and the other extensors, from the inter-muscular septa, and from the external lateral ligament of the elbow-joint. The muscular fibres terminate near the middle of the forearm, upon the under surface of a flat tendon, which descends, covered by that of the extensor carpi radialis longior, beneath the three extensors of the thumb. The tendon traverses a groove on the back of the radius, on the same plane with that of the long radial extensor, but lined by a separate synovial membrane, and is *inserted* into the radial

side of the metacarpal bone of the middle finger. A bursa is generally found between the tendon and the bone. Its nerve comes from the posterior interosseous.

EXTENSOR DIGITORUM COMMUNIS. This muscle *arises* from the common tendon attached to the external condyle, from the septa between it and the contiguous muscles, and from its strong fascial covering. About the middle of the forearm, the muscle divides into three or four fleshy slips, terminating in as many flat tendons, which pass beneath the posterior annular ligament, through a groove on the back of the radius lined by synovial membrane. On the back of the hand the tendons become broader and flatter, and diverge from each other towards the metacarpal joints of the fingers, where they become thicker and narrower, and give off, on each side, a fibrous expansion, which covers the sides of the joint. Over the first phalanx of the finger, each tendon again spreads out, receives the expanded tendons of the lumbricales and interossei muscles, and divides at the second phalanx into three portions, of which the middle is *inserted* into the upper end of the second phalanx; the two lateral, reuniting over the lower end of the second phalanx, are *inserted* into the upper end of the third.* Its nerve comes from the posterior interosseous.

The oblique aponeurotic slips which connect the tendons on the back of the hand are subject to great variety. The tendon of the index finger is commonly free; it is situated on the radial side of the proper indicator tendon, and becomes united with it at the metacarpal joint.

The tendon of the middle finger usually receives a slip from that of the ring. The tendon of the ring finger generally sends a slip to the tendons on either side of it, and, in some cases, entirely furnishes the tendon of the little finger. Thus the ring finger does not admit of independent extension.

* The extensor tendons are inserted into the periosteum; but the flexor tendons are inserted into the substance of the bone. This accounts for the facility with which the former will tear off the bones in cases of necrosis, while the latter will adhere so tightly as to require cutting before the phalanx can be removed. It probably also explains the great liability to necrosis which is so frequently observed in cases of thecal abscess.

The muscle is not only a general extensor of the fingers, but can extend some of the phalanges independently of the rest: *e.g.* it can extend the first phalanges while the second and third are flexed; or it can extend the second and third phalanges during flexion of the first.

EXTENSOR MINIMI DIGITI OR AURICULARIS. This long slender muscle, situated on the inner side of the common extensor, arises from the common tendon from the external condyle, and from the septa between it and the contiguous muscles. Its slender tendon runs separately beneath the annular ligament immediately behind the joint between the radius and ulna, in a special sheath lined by synovial membrane. At the first joint of the little finger, the tendon is joined by that of the common extensor, and both expand upon the first and second phalanges, terminating in the same manner as the extensor tendons of the other fingers. Its nerve comes from the posterior interosseous.

EXTENSOR CARPI ULNARIS. This muscle arises from the common tendon from the external condyle, from the septum between it and the extensor minimi digiti, and from the aponeurosis of the forearm. The fibres terminate upon a strong broad tendon, which traverses a distinct groove on the back of the ulna, close to the styloid process, and is inserted into the posterior aspect of the carpal end of the metacarpal bone of the little finger. Below the styloid process of the ulna, the tendon passes beneath the posterior annular ligament, over the back of the wrist, and is confined in a very strong fibrous canal, which is attached to the back of the cuneiform, pisiform, and unciform bones, and is lined by a continuation from the synovial membrane in the groove of the ulna. The action of this muscle is to extend the hand, and incline it towards the ulnar side. It is supplied by the posterior interosseous nerve.

In pronation of the forearm, the lower end of the ulna projects between the tendons of the extensor carpi ulnaris and the extensor minimi digiti. A subcutaneous bursa is sometimes found above the bone in this situation.

ANCONEUS. This small triangular muscle is situated at the outer and back part of the elbow. It is covered

by a strong layer of fascia, derived from the tendon of the triceps, and appears like a continuation of that muscle. It *arises* by a tendon from the posterior part of the external condyle of the humerus, and is *inserted* into the triangular surface on the upper fourth of the outer part of the ulna. Part of the under surface of the muscle is in contact with the capsule of the elbow-joint. Its *action* is to assist in extending the forearm. Its nerve comes from the musculo-spiral.

DISSECTION. To expose the deep layer of muscles, detach from the external condyle the extensor carpi radialis brevior, the extensor communis digitorum, the extensor minimi digiti, and the extensor carpi ulnaris; and, after noticing the vessels and nerves which enter their under surface, turn them down. The deep-seated muscles, with the posterior interosseous artery and nerve, must be dissected. The muscles exposed are:

DEEP-SEATED MUSCLES ON THE BACK OF THE FOREARM. 1. The extensor ossis metacarpi pollicis. 2. Extensor primi internodii pollicis. 3. Extensor secundi internodii pollicis. 4. Extensor indicis or indicator. 5. The supinator radii brevis. They are all supplied by branches from the posterior interosseous nerve.

EXTENSOR OSSIS METACARPI POLLICIS. This muscle *arises* from the posterior surface of the ulna below the supinator brevis, from the posterior surface of the radius, and from the interosseous membrane. The muscle crosses the radial extensors of the wrist about three inches above the carpus, and terminates in a tendon, which passes along a common groove with the extensor primi internodii pollicis, lined by synovial membrane, on the outer part of the lower end of the radius, and is *inserted* into the base of the metacarpal bone of the thumb, and frequently also by a tendinous slip into the trapezium.

EXTENSOR PRIMI INTERNODII POLLICIS. This small muscle *arises* from the posterior surface of the radius, below the preceding, and from the interosseous membrane. It descends obliquely in company with the preceding muscle, turns over the radial extensors of the wrist, and terminates upon a tendon which passes beneath the annular ligament, through the groove on the

outer part of the radius, and is *inserted* into the radial side of the base of the first phalanx of the thumb.

EXTENSOR SECUNDI INTERNODII POLLICIS. This muscle *arises* from the posterior surface of the ulna, below the last muscle, and from the interosseous membrane. The tendon receives fleshy fibres as low as the wrist, passes beneath the annular ligament, in a distinct groove on the back of the radius, crosses the tendons of the radial extensors of the wrist, proceeds over the metacarpal bone and the first phalanx of the thumb, and is *inserted* into the base of the last phalanx.

The tendons of the three extensors of the thumb may be easily distinguished in one's own hand. The extensor ossis metacarpi, and primi internodii pollicis, cross obliquely over the radial artery where it lies on the external lateral ligament of the carpus; the extensor secundi internodii pollicis crosses the artery just before it sinks into the palm, between the first and second metacarpal bones, and is a good guide to the vessel. The *action* of the three extensors of the thumb is implied by their names.

EXTENSOR INDICIS OR INDICATOR. This muscle *arises* from the posterior surface of the ulna, below the extensor secundi internodii pollicis. The tendon passes beneath the posterior annular ligament, in the same groove, on the back of the radius, with the tendons of the extensor digitorum communis. It then proceeds over the back of the hand to the first phalanx of the index finger, where it is united to the inner border of the common extensor tendon. By the *action* of this muscle the index finger can be extended independently of the others.

DISSECTION. Reflect the extensor carpi radialis brevior and the anconeus from their origins, to expose the following muscle.

SUPINATOR RADII BREVIS. This muscle embraces the upper third of the radius. It *arises* from the external lateral ligament of the elbow-joint, from the annular ligament surrounding the head of the radius, from an oblique ridge on the outer surface of the ulna below the insertion of the anconeus, and by fleshy fibres from the triangular excavation below the lesser sigmoid notch of

the ulna. The muscular fibres turn over the neck and upper part of the shaft of the radius, and are *inserted* into the upper third of this bone, as far forwards as the ridge leading from the tubercle to the insertion of the pronator teres. The muscle is traversed obliquely by the posterior interosseous nerve, which sends a branch to it, and its upper part is in contact with the capsule of the elbow-joint. It is a powerful supinator of the forearm, some of its fibres acting at nearly a right angle to the axis of the radius.

POSTERIOR INTEROSSEOUS ARTERY. This artery comes from the ulnar by a common trunk with the anterior interosseous (p. 296), and supplies the muscles on the back of the forearm. It passes between the oblique ligament and the interosseous membrane, and appears, at the back, between the supinator radii brevis and the extensor ossis metacarpi pollicis. After supplying branches to all the muscles in this situation, the artery descends, much diminished in size, between the superficial and deep layer of muscles to the wrist, where it inosculates with the carpal branches of the anterior interosseous, and the posterior carpal branches of the radial and ulnar arteries.

The largest branch of this artery is the *interosseous recurrent.* It ascends beneath the anconeus to the space between the external condyle and the olecranon, where it inosculates with the branch of the superior profunda, which descends in the substance of the triceps, and with the posterior ulnar recurrent artery.

In the lower part of the back of the forearm, a branch of the anterior interosseous artery is seen passing through the interosseous membrane to reach the back of the wrist.

POSTERIOR INTEROSSEOUS NERVE. The nerve which supplies the muscles on the back of the forearm is the *posterior interosseous,* one of the divisions of the musculo-spiral. It passes obliquely through the supinator radii brevis, and descends between the superficial and deep layer of muscles on the back of the forearm, sending to each a filament, generally in company with a branch of the posterior interosseous artery. It sends a branch to the extensor carpi radialis brevior, and supplies the supinator brevis in passing through its substance. The supinator radii longus and

outer part of the radius, and is *inserted* into the radial side of the base of the first phalanx of the thumb.

EXTENSOR SECUNDI INTERNODII POLLICIS. This muscle *arises* from the posterior surface of the ulna, below the last muscle, and from the interosseous membrane. The tendon receives fleshy fibres as low as the wrist, passes beneath the annular ligament, in a distinct groove on the back of the radius, crosses the tendons of the radial extensors of the wrist, proceeds over the metacarpal bone and the first phalanx of the thumb, and is *inserted* into the base of the last phalanx.

The tendons of the three extensors of the thumb may be easily distinguished in one's own hand. The extensor ossis metacarpi, and primi internodii pollicis, cross obliquely over the radial artery where it lies on the external lateral ligament of the carpus; the extensor secundi internodii pollicis crosses the artery just before it sinks into the palm, between the first and second metacarpal bones, and is a good guide to the vessel. The *action* of the three extensors of the thumb is implied by their names.

EXTENSOR INDICIS OR INDICATOR. This muscle *arises* from the posterior surface of the ulna, below the extensor secundi internodii pollicis. The tendon passes beneath the posterior annular ligament, in the same groove, on the back of the radius, with the tendons of the extensor digitorum communis. It then proceeds over the back of the hand to the first phalanx of the index finger, where it is united to the inner border of the common extensor tendon. By the *action* of this muscle the index finger can be extended independently of the others.

DISSECTION. Reflect the extensor carpi radialis brevior and the anconeus from their origins, to expose the following muscle.

SUPINATOR RADII BREVIS. This muscle embraces the upper third of the radius. It *arises* from the external lateral ligament of the elbow-joint, from the annular ligament surrounding the head of the radius, from an oblique ridge on the outer surface of the ulna below the insertion of the anconeus, and by fleshy fibres from the triangular excavation below the lesser sigmoid notch of

the ulna. The muscular fibres turn over the neck and upper part of the shaft of the radius, and are *inserted* into the upper third of this bone, as far forwards as the ridge leading from the tubercle to the insertion of the pronator teres. The muscle is traversed obliquely by the posterior interosseous nerve, which sends a branch to it, and its upper part is in contact with the capsule of the elbow-joint. It is a powerful supinator of the forearm, some of its fibres acting at nearly a right angle to the axis of the radius.

POSTERIOR INTEROSSEOUS ARTERY. This artery comes from the ulnar by a common trunk with the anterior interosseous (p. 296), and supplies the muscles on the back of the forearm. It passes between the oblique ligament and the interosseous membrane, and appears, at the back, between the supinator radii brevis and the extensor ossis metacarpi pollicis. After supplying branches to all the muscles in this situation, the artery descends, much diminished in size, between the superficial and deep layer of muscles to the wrist, where it inosculates with the carpal branches of the anterior interosseous, and the posterior carpal branches of the radial and ulnar arteries.

The largest branch of this artery is the *interosseous recurrent.* It ascends beneath the anconeus to the space between the external condyle and the olecranon, where it inosculates with the branch of the superior profunda, which descends in the substance of the triceps, and with the posterior ulnar recurrent artery.

In the lower part of the back of the forearm, a branch of the anterior interosseous artery is seen passing through the interosseous membrane to reach the back of the wrist.

POSTERIOR INTEROSSEOUS NERVE. The nerve which supplies the muscles on the back of the forearm is the *posterior interosseous,* one of the divisions of the musculo-spiral. It passes obliquely through the supinator radii brevis, and descends between the superficial and deep layer of muscles on the back of the forearm, sending to each a filament, generally in company with a branch of the posterior interosseous artery. It sends a branch to the extensor carpi radialis brevior, and supplies the supinator brevis in passing through its substance. The supinator radii longus and

the extensor carpi radialis longior are supplied by distinct branches from the musculo-spiral.

The continuation of the posterior interosseous nerve descends beneath the extensor secundi internodii pollicis and the tendons of the extensor digitorum communis to the back of the wrist. Behind

Fig. 61.

1. The superior profunda.
2. The anastomotica magna.
3. The posterior ulnar recurrent.
4. The posterior interosseous } its ascending and descending branches.
5. The termination of the anterior interosseous.
6. The posterior carpal arch.

DIAGRAM SHOWING THE ANASTOMOSES OF ARTERIES AT THE BACK OF THE ELBOW AND WRIST JOINTS.

the common extensor tendons the nerve forms a gangliform enlargement from which filaments are sent to the carpal and metacarpal joints.

Dissection. Radial Artery on the Back of the Wrist. The radial artery is continued over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, to the proximal part of the interval between the first and second metacarpal

bones, where it dips down between the two origins of the abductor indicis, and, entering the palm, forms the deep palmar arch. In this part of its course it is crossed by filaments of the radial nerve; observe, also, that the tendon of the extensor secundi internodii pollicis passes over it immediately before it sinks into the palm. It supplies the following small branches to the back of the hand:—

a. Posterior carpal artery.—This branch passes across the carpal bones, beneath the extensor tendons. It inosculates with the termination of the anterior interosseous artery, and forms an arch beneath the extensor tendons, with a corresponding branch from the ulnar artery. The carpal artery sends off small branches, called the *dorsal interosseous*, which descend along the third and fourth interosseous spaces from the arch just mentioned, beneath the extensor tendons, and inosculate near the carpal ends of the metacarpal bones with the perforating branches from the deep palmar arch.

b. The *first dorsal interosseous artery* is generally larger than the others. It passes towards the second interosseous space to the cleft between the index and middle fingers, communicating here with a perforating branch of the deep palmar arch, and terminates in small branches, some of which proceed along the back of the fingers, others inosculate with the palmar digital arteries.

c. The *dorsal artery of the index-finger*, a branch of variable size, passes over the first interosseous muscle to the radial side of the back of the index finger.

d. The *dorsal arteries of the thumb* are two small branches which arise from the radial opposite the head of the first metacarpal bone, and run along the back of the thumb, one on either side. They are often absent.

These dorsal interosseous arteries supply the extensor tendons and their sheaths, the interosseous muscles, and the skin on the back of the hand, and the first phalanges of the fingers.

DISSECTION. Remove the tendons from the back, and from the palm, of the hand: observe the deep palmar fascia which covers the interosseous muscles. It is attached to the ridges of the metacarpal bones, forms a distinct sheath for each interosseous muscle, and is continuous inferiorly with the

transverse metacarpal ligament. On the back of the hand the interosseous muscles are covered by a thin fascia, which is attached to the adjacent borders of the metacarpal bones.

TRANSVERSE METACARPAL LIGAMENT. This consists of strong bands of ligamentous fibres, which pass transversely between the distal extremities of the metacarpal bones. These bands are intimately united to the fibro-cartilaginous ligament of the metacarpal joints, and are of sufficient length to admit of a certain degree of movement between the ends of the metacarpal bones.

FIG. 62.

DIAGRAM OF THE FOUR DORSAL INTEROSSEI, DRAWING FROM THE MIDDLE LINE.

FIG. 63.

DIAGRAM OF THE THREE PALMAR INTEROSSEI, AND THE ADDUCTOR POLLICIS, DRAWING TOWARDS THE MIDDLE LINE.

DISSECTION. Remove the fascia which covers the interosseous muscles, and separate the metacarpal bones by dividing the transverse metacarpal ligament. A *bursa* is frequently developed between their digital extremities.

INTEROSSEOUS MUSCLES. These muscles, so named from their position, extend from the sides of the metacarpal bones to the bases of the first phalanges and the extensor tendons of the fingers. In each interosseous space (except the first, in which there is only an abductor) there are two muscles, one of which

is an abductor, the other an adductor, of a finger. Thus there are *seven* in all; four of which, situated on the back of the hand, are called dorsal; the remainder, seen only in the palm, are called palmar.* They are all supplied by the ulnar nerve.

DORSAL INTEROSSEI. Each dorsal interosseous muscle *arises* from the opposite sides of two contiguous metacarpal bones (fig. 62). From this double origin the fibres converge to a tendon, which passes between the metacarpal joints of the finger, and is *inserted* into the side of the base of the first phalanx, and by a broad expansion into the extensor tendon on the back of the same finger.

The *first* dorsal interosseous muscle (*abductor indicis*) is larger than the others, and occupies the interval between the thumb and fore-finger. It *arises* from the proximal half of the ulnar side of the first metacarpal bone, and from the entire length of the radial side of the second: between the two origins, the radial artery passes into the palm. Its fibres converge on either side to a tendon, which is *inserted* into the *radial* side of the first phalanx of the index finger and its extensor tendon.

The *second* dorsal interosseous muscle occupies the second metacarpal space. It is *inserted* into the radial side of the first phalanx of the middle finger and its extensor tendon.

The *third* and *fourth*, occupying the corresponding metacarpal spaces, are *inserted*, the one into the ulnar side of the middle, the other into the ulnar side of the ring finger.

If a line be drawn longitudinally through the middle finger, as represented by the dotted line in fig. 62, we find that all the dorsal interosseous muscles are abductors from that line; consequently, they separate the fingers from each other.

PALMAR INTEROSSEOUS. It requires a careful examination to distinguish this set of muscles, because the dorsal muscles protrude with them into the palm. They are smaller than the dorsal, and each *arises* from the lateral surface of only one metacarpal bone—that, namely, connected with the finger into which

* If we consider the adductor pollicis as a palmar interosseous muscle, there would be four palmar and four dorsal—all supplied by the ulnar nerve.

the muscle is inserted (fig. 63). They terminate in small tendons, which pass between the metacarpal joints of the fingers, and are *inserted*, like those of the dorsal muscles, into the sides of the first phalanges and the extensor tendons on the back of the fingers.

The *first* palmar interosseous muscle *arises* from the ulnar side of the second metacarpal bone, and is *inserted* into the ulnar side of the index finger. The *second* and *third* arise, the one from the radial side of the fourth, the other from the radial side of the fifth metacarpal bone, and are *inserted* into the same sides of the ring and little fingers.

The palmar interosseous muscles are all adductors to a line drawn through the middle finger (fig. 63). They are, therefore, the opponents of the dorsal interosseous, and move the fingers towards each other.

The palmar and dorsal interossei are supplied by filaments from the deep branch of the ulnar nerve.

DISSECTION OF THE LIGAMENTS.

STERNO-CLAVICULAR JOINT. The inner end of the clavicle articulates with the comparatively small and shallow excavation on the upper and outer part of the sternum. The security of the joint depends upon the great strength of its ligaments. There are two synovial membranes, and an intervening fibro-cartilage.

The *anterior sterno-clavicular ligament* (fig. 64) consists of a strong broad band of ligamentous fibres, which pass obliquely downwards and inwards over the front of the joint, from the inner end of the clavicle to the anterior surface of the sternum.

The *posterior sterno-clavicular ligament* extends over the back of the joint, from the back of the clavicle to the back of the sternum in a similar manner to the anterior.

The *inter-clavicular ligament* connects the clavicles directly. It extends transversely above the notch of the sternum, and has a attachment to the upper border of each clavicle. Between

the clavicles it is more or less attached to the sternum, so that it forms a curve with the concavity upwards.

The three ligaments just described are so closely connected that, collectively, they form for the joint a complete fibrous capsule of such strength that dislocation of it is rare.

The *costo-clavicular* or *rhomboid* ligament connects the clavicle to the cartilage of the first rib. It ascends obliquely outwards and backwards from the cartilage of the rib to a rough surface beneath the sternal end of the clavicle. Its use is to limit the elevation of the clavicle. There is such constant movement between the clavicle and the cartilage of the first rib that a well-marked *bursa* is commonly found between them.

FIG. 64.

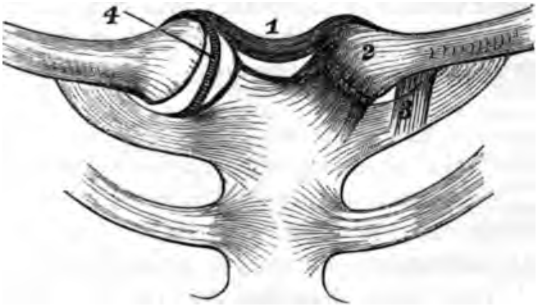

DIAGRAM OF THE STERNO-CLAVICULAR LIGAMENTS.

1. Inter-clavicular ligament.
2. Anterior sterno-clavicular ligament.
3. Costo-clavicular ligament.
4. Inter-articular fibro-cartilage.

Inter-articular fibro-cartilage.—To see this, cut through the rhomboid, the anterior and posterior ligaments of the joint, and raise the clavicle. It is nearly circular in form, and thicker at the circumference than the centre, in which there is sometimes a perforation. Inferiorly, it is attached to the cartilage of the first rib, close to the sternum; superiorly, to the upper part of the clavicle and the inter-clavicular ligament. Its circumference is inseparably connected with the anterior and posterior ligaments.

The joint is provided with two synovial membranes: one between the articular surface of the sternum and the inner surface

The muscle is not only a general extensor of the fingers, but can extend some of the phalanges independently of the rest: *e.g.* it can extend the first phalanges while the second and third are flexed; or it can extend the second and third phalanges during flexion of the first.

EXTENSOR MINIMI DIGITI OR AURICULARIS. This long slender muscle, situated on the inner side of the common extensor, *arises* from the common tendon from the external condyle, and from the septa between it and the contiguous muscles. Its slender tendon runs separately beneath the annular ligament immediately behind the joint between the radius and ulna, in a special sheath lined by synovial membrane. At the first joint of the little finger, the tendon is joined by that of the common extensor, and both expand upon the first and second phalanges, terminating in the same manner as the extensor tendons of the other fingers. Its nerve comes from the posterior interosseous.

EXTENSOR CARPI ULNARIS. This muscle *arises* from the common tendon from the external condyle, from the septum between it and the extensor minimi digiti, and from the aponeurosis of the forearm. The fibres terminate upon a strong broad tendon, which traverses a distinct groove on the back of the ulna, close to the styloid process, and is *inserted* into the posterior aspect of the carpal end of the metacarpal bone of the little finger. Below the styloid process of the ulna, the tendon passes beneath the posterior annular ligament, over the back of the wrist, and is confined in a very strong fibrous canal, which is attached to the back of the cuneiform, pisiform, and unciform bones, and is lined by a continuation from the synovial membrane in the groove of the ulna. The *action* of this muscle is to extend the hand, and incline it towards the ulnar side. It is supplied by the posterior interosseous nerve.

In pronation of the forearm, the lower end of the ulna projects between the tendons of the extensor carpi ulnaris and the extensor minimi digiti. A subcutaneous *bursa* is sometimes found above the bone in this situation.

ANCONEUS. This small triangular muscle is situated at the outer and back part of the elbow. It is covered

by a strong layer of fascia, derived from the tendon of the triceps, and appears like a continuation of that muscle. It *arises* by a tendon from the posterior part of the external condyle of the humerus, and is *inserted* into the triangular surface on the upper fourth of the outer part of the ulna. Part of the under surface of the muscle is in contact with the capsule of the elbow-joint. Its *action* is to assist in extending the forearm. Its nerve comes from the musculo-spiral.

DISSECTION. To expose the deep layer of muscles, detach from the external condyle the extensor carpi radialis brevior, the extensor communis digitorum, the extensor minimi digiti, and the extensor carpi ulnaris; and, after noticing the vessels and nerves which enter their under surface, turn them down. The deep-seated muscles, with the posterior interosseous artery and nerve, must be dissected. The muscles exposed are:

DEEP-SEATED MUSCLES ON THE BACK OF THE FOREARM. 1. The extensor ossis metacarpi pollicis. 2. Extensor primi internodii pollicis. 3. Extensor secundi internodii pollicis. 4. Extensor indicis or indicator. 5. The supinator radii brevis. They are all supplied by branches from the posterior interosseous nerve.

EXTENSOR OSSIS METACARPI POLLICIS. This muscle *arises* from the posterior surface of the ulna below the supinator brevis, from the posterior surface of the radius, and from the interosseous membrane. The muscle crosses the radial extensors of the wrist about three inches above the carpus, and terminates in a tendon, which passes along a common groove with the extensor primi internodii pollicis, lined by synovial membrane, on the outer part of the lower end of the radius, and is *inserted* into the base of the metacarpal bone of the thumb, and frequently also by a tendinous slip into the trapezium.

EXTENSOR PRIMI INTERNODII POLLICIS. This small muscle *arises* from the posterior surface of the radius, below the preceding, and from the interosseous membrane. It descends obliquely in company with the preceding muscle, turns over the radial extensors of the wrist, and terminates upon a tendon which passes beneath the annular ligament, through the groove on the

The muscle is not only a general extensor of the fingers, but can extend some of the phalanges independently of the rest: *e.g.* it can extend the first phalanges while the second and third are flexed; or it can extend the second and third phalanges during flexion of the first.

EXTENSOR MINIMI DIGITI OR AURICULARIS. This long slender muscle, situated on the inner side of the common extensor, *arises* from the common tendon from the external condyle, and from the septa between it and the contiguous muscles. Its slender tendon runs separately beneath the annular ligament immediately behind the joint between the radius and ulna, in a special sheath lined by synovial membrane. At the first joint of the little finger, the tendon is joined by that of the common extensor, and both expand upon the first and second phalanges, terminating in the same manner as the extensor tendons of the other fingers. Its nerve comes from the posterior interosseous.

EXTENSOR CARPI ULNARIS. This muscle *arises* from the common tendon from the external condyle, from the septum between it and the extensor minimi digiti, and from the aponeurosis of the forearm. The fibres terminate upon a strong broad tendon, which traverses a distinct groove on the back of the ulna, close to the styloid process, and is *inserted* into the posterior aspect of the carpal end of the metacarpal bone of the little finger. Below the styloid process of the ulna, the tendon passes beneath the posterior annular ligament, over the back of the wrist, and is confined in a very strong fibrous canal, which is attached to the back of the cuneiform, pisiform, and unciform bones, and is lined by a continuation from the synovial membrane in the groove of the ulna. The *action* of this muscle is to extend the hand, and incline it towards the ulnar side. It is supplied by the posterior interosseous nerve.

In pronation of the forearm, the lower end of the ulna projects between the tendons of the extensor carpi ulnaris and the extensor minimi digiti. A subcutaneous *bursa* is sometimes found above the bone in this situation.

ANCONEUS. This small triangular muscle is situated at the outer and back part of the elbow. It is covered

by a strong layer of fascia, derived from the tendon of the triceps, and appears like a continuation of that muscle. It *arises* by a tendon from the posterior part of the external condyle of the humerus, and is *inserted* into the triangular surface on the upper fourth of the outer part of the ulna. Part of the under surface of the muscle is in contact with the capsule of the elbow-joint. Its *action* is to assist in extending the forearm. Its nerve comes from the musculo-spiral.

DISSECTION. To expose the deep layer of muscles, detach from the external condyle the extensor carpi radialis brevior, the extensor communis digitorum, the extensor minimi digiti, and the extensor carpi ulnaris; and, after noticing the vessels and nerves which enter their under surface, turn them down. The deep-seated muscles, with the posterior interosseous artery and nerve, must be dissected. The muscles exposed are:

DEEP-SEATED MUSCLES ON THE BACK OF THE FOREARM. 1. The extensor ossis metacarpi pollicis. 2. Extensor primi internodii pollicis. 3. Extensor secundi internodii pollicis. 4. Extensor indicis or indicator. 5. The supinator radii brevis. They are all supplied by branches from the posterior interosseous nerve.

EXTENSOR OSSIS METACARPI POLLICIS. This muscle *arises* from the posterior surface of the ulna below the supinator brevis, from the posterior surface of the radius, and from the interosseous membrane. The muscle crosses the radial extensors of the wrist about three inches above the carpus, and terminates in a tendon, which passes along a common groove with the extensor primi internodii pollicis, lined by synovial membrane, on the outer part of the lower end of the radius, and is *inserted* into the base of the metacarpal bone of the thumb, and frequently also by a tendinous slip into the trapezium.

EXTENSOR PRIMI INTERNODII POLLICIS. This small muscle *arises* from the posterior surface of the radius, below the preceding, and from the interosseous membrane. It descends obliquely in company with the preceding muscle, turns over the radial extensors of the wrist, and terminates upon a tendon which passes beneath the annular ligament, through the groove on the

outer part of the radius, and is *inserted* into the radial side of the base of the first phalanx of the thumb.

EXTENSOR SECUNDI INTERNODII POLLICIS. This muscle *arises* from the posterior surface of the ulna, below the last muscle, and from the interosseous membrane. The tendon receives fleshy fibres as low as the wrist, passes beneath the annular ligament, in a distinct groove on the back of the radius, crosses the tendons of the radial extensors of the wrist, proceeds over the metacarpal bone and the first phalanx of the thumb, and is *inserted* into the base of the last phalanx.

The tendons of the three extensors of the thumb may be easily distinguished in one's own hand. The extensor ossis metacarpi, and primi internodii pollicis, cross obliquely over the radial artery where it lies on the external lateral ligament of the carpus; the extensor secundi internodii pollicis crosses the artery just before it sinks into the palm, between the first and second metacarpal bones, and is a good guide to the vessel. The *action* of the three extensors of the thumb is implied by their names.

EXTENSOR INDICIS OR INDICATOR. This muscle *arises* from the posterior surface of the ulna, below the extensor secundi internodii pollicis. The tendon passes beneath the posterior annular ligament, in the same groove, on the back of the radius, with the tendons of the extensor digitorum communis. It then proceeds over the back of the hand to the first phalanx of the index finger, where it is united to the inner border of the common extensor tendon. By the *action* of this muscle the index finger can be extended independently of the others.

DISSECTION. Reflect the extensor carpi radialis brevior and the anconeus from their origins, to expose the following muscle.

SUPINATOR RADII BREVIS. This muscle embraces the upper third of the radius. It *arises* from the external lateral ligament of the elbow-joint, from the annular ligament surrounding the head of the radius, from an oblique ridge on the outer surface of the ulna below the insertion of the anconeus, and by fleshy fibres from the triangular excavation below the lesser sigmoid notch of

the ulna. The muscular fibres turn over the neck and upper part of the shaft of the radius, and are *inserted* into the upper third of this bone, as far forwards as the ridge leading from the tubercle to the insertion of the pronator teres. The muscle is traversed obliquely by the posterior interosseous nerve, which sends a branch to it, and its upper part is in contact with the capsule of the elbow-joint. It is a powerful supinator of the forearm, some of its fibres acting at nearly a right angle to the axis of the radius.

POSTERIOR INTEROSSEOUS ARTERY. This artery comes from the ulnar by a common trunk with the anterior interosseous (p. 296), and supplies the muscles on the back of the forearm. It passes between the oblique ligament and the interosseous membrane, and appears, at the back, between the supinator radii brevis and the extensor ossis metacarpi pollicis. After supplying branches to all the muscles in this situation, the artery descends, much diminished in size, between the superficial and deep layer of muscles to the wrist, where it inosculates with the carpal branches of the anterior interosseous, and the posterior carpal branches of the radial and ulnar arteries.

The largest branch of this artery is the *interosseous recurrent*. It ascends beneath the anconeus to the space between the external condyle and the olecranon, where it inosculates with the branch of the superior profunda, which descends in the substance of the triceps, and with the posterior ulnar recurrent artery.

In the lower part of the back of the forearm, a branch of the anterior interosseous artery is seen passing through the interosseous membrane to reach the back of the wrist.

POSTERIOR INTEROSSEOUS NERVE. The nerve which supplies the muscles on the back of the forearm is the *posterior interosseous*, one of the divisions of the musculo-spiral. It passes obliquely through the supinator radii brevis, and descends between the superficial and deep layer of muscles on the back of the forearm, sending to each a filament, generally in company with a branch of the posterior interosseous artery. It sends a branch to the extensor carpi radialis brevior, and supplies the supinator brevis in passing through its substance. The supinator radii longus and

the extensor carpi radialis longior are supplied by distinct branches from the musculo-spiral.

The continuation of the posterior interosseous nerve descends beneath the extensor secundi internodii pollicis and the tendons of the extensor digitorum communis to the back of the wrist. Behind

FIG. 61.

1. The superior profunda.
2. The anastomotica magna.
3. The posterior ulnar recurrent.
4. The posterior interosseous } its ascending and descending branches.
5. The termination of the anterior interosseous.
6. The posterior carpal arch.

DIAGRAM SHOWING THE ANASTOMOSES OF ARTERIES AT THE BACK OF THE ELBOW AND WRIST JOINTS.

the common extensor tendons the nerve forms a gangliform enlargement from which filaments are sent to the carpal and metacarpal joints.

DISSECTION. RADIAL ARTERY ON THE BACK OF THE WRIST.

The radial artery is continued over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, to the proximal part of the interval between the first and second metacarpal

bones, where it dips down between the two origins of the abductor indicis, and, entering the palm, forms the deep palmar arch. In this part of its course it is crossed by filaments of the radial nerve; observe, also, that the tendon of the extensor secundi internodii pollicis passes over it immediately before it sinks into the palm. It supplies the following small branches to the back of the hand:—

a. Posterior carpal artery.—This branch passes across the carpal bones, beneath the extensor tendons. It inosculates with the termination of the anterior interosseous artery, and forms an arch beneath the extensor tendons, with a corresponding branch from the ulnar artery. The carpal artery sends off small branches, called the *dorsal interosseous*, which descend along the third and fourth interosseous spaces from the arch just mentioned, beneath the extensor tendons, and inosculate near the carpal ends of the metacarpal bones with the perforating branches from the deep palmar arch.

b. The *first dorsal interosseous artery* is generally larger than the others. It passes towards the second interosseous space to the cleft between the index and middle fingers, communicating here with a perforating branch of the deep palmar arch, and terminates in small branches, some of which proceed along the back of the fingers, others inosculate with the palmar digital arteries.

c. The *dorsal artery of the index-finger*, a branch of variable size, passes over the first interosseous muscle to the radial side of the back of the index finger.

d. The *dorsal arteries of the thumb* are two small branches which arise from the radial opposite the head of the first metacarpal bone, and run along the back of the thumb, one on either side. They are often absent.

These dorsal interosseous arteries supply the extensor tendons and their sheaths, the interosseous muscles, and the skin on the back of the hand, and the first phalanges of the fingers.

Dissection. Remove the tendons from the back, and from the palm, of the hand: observe the deep palmar fascia which covers the interosseous muscles. It is attached to the ridges of the metacarpal bones, forms a distinct sheath for each interosseous muscle, and is continuous inferiorly with the

transverse metacarpal ligament. On the back of the hand the interosseous muscles are covered by a thin fascia, which is attached to the adjacent borders of the metacarpal bones.

TRANSVERSE METACARPAL LIGAMENT. This consists of strong bands of ligamentous fibres, which pass transversely between the distal extremities of the metacarpal bones. These bands are intimately united to the fibro-cartilaginous ligament of the metacarpal joints, and are of sufficient length to admit of a certain degree of movement between the ends of the metacarpal bones.

FIG. 62.

DIAGRAM OF THE FOUR DORSAL INTEROSSEI, DRAWING FROM THE MIDDLE LINE.

FIG. 63.

DIAGRAM OF THE THREE PALMAR INTEROSSEI, AND THE ADDUCTOR POLLICIS, DRAWING TOWARDS THE MIDDLE LINE.

DISSECTION. Remove the fascia which covers the interosseous muscles, and separate the metacarpal bones by dividing the transverse metacarpal ligament. A *bursa* is frequently developed between their digital extremities.

INTEROSSEOUS MUSCLES. These muscles, so named from their position, extend from the sides of the metacarpal bones to the bases of the first phalanges and the extensor tendons of the fingers. In each interosseous space (except the first, in which there is only an abductor) there are two muscles, one of which

is an abductor, the other an adductor, of a finger. Thus there are *seven* in all; four of which, situated on the back of the hand, are called dorsal; the remainder, seen only in the palm, are called palmar.* They are all supplied by the ulnar nerve.

DORSAL INTEROSSEI. Each dorsal interosseous muscle *arises* from the opposite sides of two contiguous metacarpal bones (fig. 62). From this double origin the fibres converge to a tendon, which passes between the metacarpal joints of the finger, and is *inserted* into the side of the base of the first phalanx, and by a broad expansion into the extensor tendon on the back of the same finger.

The *first* dorsal interosseous muscle (*abductor indicis*) is larger than the others, and occupies the interval between the thumb and fore-finger. It *arises* from the proximal half of the ulnar side of the first metacarpal bone, and from the entire length of the radial side of the second: between the two origins, the radial artery passes into the palm. Its fibres converge on either side to a tendon, which is *inserted* into the *radial* side of the first phalanx of the index finger and its extensor tendon.

The *second* dorsal interosseous muscle occupies the second metacarpal space. It is *inserted* into the radial side of the first phalanx of the middle finger and its extensor tendon.

The *third* and *fourth*, occupying the corresponding metacarpal spaces, are *inserted*, the one into the ulnar side of the middle, the other into the ulnar side of the ring finger.

If a line be drawn longitudinally through the middle finger, as represented by the dotted line in fig. 62, we find that all the dorsal interosseous muscles are abductors from that line; consequently, they separate the fingers from each other.

PALMAR INTEROSSEOUS. It requires a careful examination to distinguish this set of muscles, because the dorsal muscles protrude with them into the palm. They are smaller than the dorsal, and each *arises* from the lateral surface of only one metacarpal bone—that, namely, connected with the finger into which

* If we consider the adductor pollicis as a palmar interosseous muscle, there would be four palmar and four dorsal—all supplied by the ulnar nerve.

the muscle is inserted (fig. 63). They terminate in small tendons, which pass between the metacarpal joints of the fingers, and are *inserted*, like those of the dorsal muscles, into the sides of the first phalanges and the extensor tendons on the back of the fingers.

The *first* palmar interosseous muscle *arises* from the ulnar side of the second metacarpal bone, and is *inserted* into the ulnar side of the index finger. The *second* and *third* arise, the one from the radial side of the fourth, the other from the radial side of the fifth metacarpal bone, and are *inserted* into the same sides of the ring and little fingers.

The palmar interosseous muscles are all adductors to a line drawn through the middle finger (fig. 63). They are, therefore, the opponents of the dorsal interosseous, and move the fingers towards each other.

The palmar and dorsal interossei are supplied by filaments from the deep branch of the ulnar nerve.

DISSECTION OF THE LIGAMENTS.

STERNO-CLAVICULAR JOINT. The inner end of the clavicle articulates with the comparatively small and shallow excavation on the upper and outer part of the sternum. The security of the joint depends upon the great strength of its ligaments. There are two synovial membranes, and an intervening fibro-cartilage.

The *anterior sterno-clavicular ligament* (fig. 64) consists of a strong broad band of ligamentous fibres, which pass obliquely downwards and inwards over the front of the joint, from the inner end of the clavicle to the anterior surface of the sternum.

The *posterior sterno-clavicular ligament* extends over the back of the joint, from the back of the clavicle to the back of the sternum in a similar manner to the anterior.

The *inter-clavicular ligament* connects the clavicles directly. It extends transversely above the notch of the sternum, and has a broad attachment to the upper border of each clavicle. Between

the clavicles it is more or less attached to the sternum, so that it forms a curve with the concavity upwards.

The three ligaments just described are so closely connected that, collectively, they form for the joint a complete fibrous capsule of such strength that dislocation of it is rare.

The *costo-clavicular* or *rhomboid* ligament connects the clavicle to the cartilage of the first rib. It ascends obliquely outwards and backwards from the cartilage of the rib to a rough surface beneath the sternal end of the clavicle. Its use is to limit the elevation of the clavicle. There is such constant movement between the clavicle and the cartilage of the first rib that a well-marked *bursa* is commonly found between them.

FIG. 64.

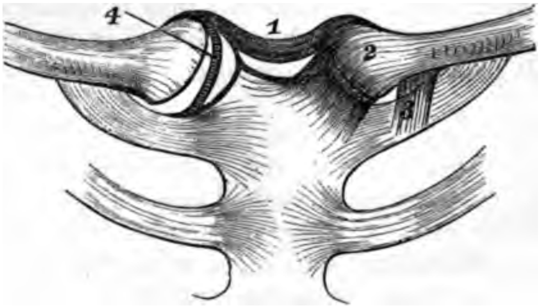

DIAGRAM OF THE STERNO-CLAVICULAR LIGAMENTS.

1. Inter-clavicular ligament.
2. Anterior sterno-clavicular ligament.
3. Costo-clavicular ligament.
4. Inter-articular fibro-cartilage.

Inter-articular fibro-cartilage.—To see this, cut through the rhomboid, the anterior and posterior ligaments of the joint, and raise the clavicle. It is nearly circular in form, and thicker at the circumference than the centre, in which there is sometimes a perforation. Inferiorly, it is attached to the cartilage of the first rib, close to the sternum; superiorly, to the upper part of the clavicle and the inter-clavicular ligament. Its circumference is inseparably connected with the anterior and posterior ligaments.

The joint is provided with two synovial membranes: one between the articular surface of the sternum and the inner surface

of the fibro-cartilage; the other between the articular surface of the clavicle and the outer surface of the fibro-cartilage.

This inter-articular fibro-cartilage is a structure highly elastic, without admitting of any stretching. It equalises pressure, breaks shocks, and also acts as a ligament, tending to prevent the clavicle from being driven inwards towards the mesial line.

Observe the relative form of the cartilaginous surfaces of the bones: that of the sternum is slightly concave in the transverse, and convex in the antero-posterior direction; that of the clavicle is the reverse.

The form of the articular surfaces and the ligaments of a joint being known, it is easy to understand the movements of which it is capable. The clavicle can be moved upon the sternum in a direction either vertical or horizontal: thus it admits of circumduction. These movements, though limited at the sternum, are considerable at the apex of the shoulder.

SCAPULO-CLAVICULAR JOINT.

The outer end of the clavicle articulates with the acromion, and is connected by strong ligaments to the coracoid process of the scapula.

The clavicle and the acromion articulate with each other by two flat oval cartilaginous surfaces, of which the planes slant inwards, and the longer diameters are in the antero-posterior direction.

The *superior ligament*, a broad band of ligamentous fibres, strengthened by the aponeurosis of the trapezius, extends from the upper surface of the acromion to the upper surface of the clavicle.

The *inferior ligament*, of less strength, extends along the under surface of the joint from bone to bone.

An *inter-articular fibro-cartilage* is sometimes found in this joint: but it is incomplete, and seldom extends lower than the upper half. There is only one synovial membrane.

Coraco-clavicular ligament.—The clavicle is connected to the coracoid process of the scapula by two strong ligaments—the *conoid* and *trapezoid*, which, being continuous with each other, should be considered as one. The *trapezoid* ligament is the more

anterior and external. It arises from the back part of the coracoid process, and ascends obliquely backwards and outwards to the clavicle, near its outer end. The *conoid* ligament is fixed at its apex to the root of the coracoid process, ascends nearly vertically, and is attached by its base to the clavicle. When the clavicle is fractured in the line of the attachment of the coraco-clavicular ligament, there is little or no displacement of the fractured ends, these being kept in place by the ligament.

LIGAMENTS OF THE SCAPULA. These are two: the transverse ligament, attached to the margins of the supra-scapular notch; and the *coraco-acromial* or *triangular* ligament, attached by its

FIG. 65.

1. Trapezoid } portions of the coraco-
2. Conoid } clavicular ligament.
3. Supra-scapular or transverse ligament.
4. Coraco-acromial ligament.

5. Tendon of biceps.
6. Capsular ligament of the shoulder-joint.
7. Coraco-humeral ligament.
8. Foramen in the capsular ligament for the subscapularis tendon.

ANTERIOR VIEW OF THE SCAPULO-CLAVICULAR LIGAMENTS, AND OF THE SHOULDER-JOINT.

apex to the acromion, and by its base to the outer border of the coracoid process. It is separated from the upper part of the capsule of the shoulder-joint by a large *bursa*.

SHOULDER-JOINT. The articular surface of the head of the humerus, forming rather more than one-third of a sphere, moves upon the shallow glenoid cavity of the scapula, which is of an oval form, with the broader end downwards, and the long diameter nearly vertical. The security of the joint depends, not upon any mechanical contrivance of the bones, but upon the great strength and number of the tendons which surround and are intimately connected with it.

To admit the free motion of the head of the humerus upon the glenoid cavity, it is requisite that the *capsular ligament* of the joint be loose and capacious. Accordingly, the head of the bone, when detached from its muscular connections, may be separated from the glenoid cavity to the extent of an inch, or more, without laceration of the capsule. This explains the elongation of the arm observed in some cases in which effusion takes place into the joint; also in cases of paralysis of the deltoid.

The *capsular ligament* is attached above, round the circumference of the glenoid cavity; below, round the anatomical neck of the humerus. It is strongest on its upper aspect, weakest and longest on its lower. It is strengthened on its upper and posterior part by the tendons of the supra-spinatus, infra-spinatus, and teres minor; its inner part is strengthened by the broad tendon of the subscapularis, its lower part by the long head of the triceps.

Thus the circumference of the capsule is surrounded by tendons on every side, excepting a small space towards the axilla. If the humerus be raised, it will be found that the head of the bone rests upon this unprotected portion of the capsule, between the tendons of the subscapularis and the long head of the triceps: through this part of the capsule the head of the bone is first protruded in dislocations into the axilla.

At the upper and inner side of the joint, a small opening (*foramen ovale*) is observable in the capsular ligament, through which the tendon of the subscapularis passes, and comes in contact with the synovial membrane.

The upper surface of the capsule is strengthened by a strong band of ligamentous fibres, called the *coraco-humeral* or *accessory ligament.* It is attached to the root of the coracoid process, expands over the upper surface of the capsule, with which it is inseparably united, and is fixed into the greater tuberosity of the humerus.

Open the capsule to see the tendon of the long head of the biceps. It enters the joint through the groove between the two tuberosities, becomes slightly flattened, and passes over the head

of the bone to be attached to the upper border of the glenoid cavity. It is loose and movable within the joint. It acts like a strap, keeping down the head of the bone when the arm is raised by the deltoid.

The tendon of the biceps, strictly speaking, does not perforate the synovial membrane of the joint. It is inclosed in a tubular sheath, which is reflected over it at its attachment to the glenoid cavity, and accompanies it for two inches down the groove of the humerus. During the earlier part of fœtal life, it is connected to the capsule by a fold of synovial membrane, which subsequently disappears.

The margin of the glenoid cavity of the scapula is surrounded by a fibrous band of considerable thickness, called the *glenoid ligament.* This not only enlarges, but deepens the cavity. Superiorly, it is continuous on either side with the tendon of the biceps; inferiorly, with the tendon of the triceps: in the rest of its circumference it is attached to the edge of the cavity.

The cartilage covering the head of the humerus is thicker at the centre than at the circumference. The reverse is the case in the glenoid cavity.

The *synovial membrane* lining the under surface of the capsule is reflected around the tendon of the biceps, and passes with it in the form of a cul-de-sac down the bicipital groove. On the inner side of the joint it always communicates with the bursa beneath the tendon of the subscapularis.

The shoulder-joint has a more extensive range of motion than any other joint in the body; it is what mechanics call a universal joint. It is capable of motion forwards and backwards, of adduction, abduction, circumduction, and rotation.

ELBOW-JOINT.

The elbow-joint is a perfect hinge. The larger sigmoid cavity of the ulna is adapted to the trochlea upon the lower end of the humerus, admitting only of flexion and extension; while the shallow excavation upon the head of the radius admits not only of flexion and extension, but of rotation, upon the rounded articular eminence (*capitellum*) of the

the extensor carpi radialis longior are supplied by distinct branches from the musculo-spiral.

The continuation of the posterior interosseous nerve descends beneath the extensor secundi internodii pollicis and the tendons of the extensor digitorum communis to the back of the wrist. Behind

Fig. 61.

1. The superior profunda.
2. The anastomotica magna.
3. The posterior ulnar recurrent.
4. The posterior interosseous } its ascending and descending branches.
5. The termination of the anterior interosseous.
6. The posterior carpal arch.

DIAGRAM SHOWING THE ANASTOMOSES OF ARTERIES AT THE BACK OF THE ELBOW AND WRIST JOINTS.

the common extensor tendons the nerve forms a gangliform enlargement from which filaments are sent to the carpal and metacarpal joints.

Dissection. Radial Artery on the Back of the Wrist. The radial artery is continued over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, to the proximal part of the interval between the first and second metacarpal

bones, where it dips down between the two origins of the abductor indicis, and, entering the palm, forms the deep palmar arch. In this part of its course it is crossed by filaments of the radial nerve; observe, also, that the tendon of the extensor secundi internodii pollicis passes over it immediately before it sinks into the palm. It supplies the following small branches to the back of the hand:—

a. *Posterior carpal artery.*—This branch passes across the carpal bones, beneath the extensor tendons. It inosculates with the termination of the anterior interosseous artery, and forms an arch beneath the extensor tendons, with a corresponding branch from the ulnar artery. The carpal artery sends off small branches, called the *dorsal interosseous*, which descend along the third and fourth interosseous spaces from the arch just mentioned, beneath the extensor tendons, and inosculate near the carpal ends of the metacarpal bones with the perforating branches from the deep palmar arch.

b. The *first dorsal interosseous artery* is generally larger than the others. It passes towards the second interosseous space to the cleft between the index and middle fingers, communicating here with a perforating branch of the deep palmar arch, and terminates in small branches, some of which proceed along the back of the fingers, others inosculate with the palmar digital arteries.

c. The *dorsal artery of the index-finger*, a branch of variable size, passes over the first interosseous muscle to the radial side of the back of the index finger.

d. The *dorsal arteries of the thumb* are two small branches which arise from the radial opposite the head of the first metacarpal bone, and run along the back of the thumb, one on either side. They are often absent.

These dorsal interosseous arteries supply the extensor tendons and their sheaths, the interosseous muscles, and the skin on the back of the hand, and the first phalanges of the fingers.

DISSECTION. Remove the tendons from the back, and from the palm, of the hand: observe the deep palmar fascia which covers the interosseous muscles. It is attached to the ridges of the metacarpal bones, forms a distinct sheath for each interosseous muscle, and is continuous inferiorly with the

transverse metacarpal ligament. On the back of the hand the interosseous muscles are covered by a thin fascia, which is attached to the adjacent borders of the metacarpal bones.

TRANSVERSE METACARPAL LIGAMENT. This consists of strong bands of ligamentous fibres, which pass transversely between the distal extremities of the metacarpal bones. These bands are intimately united to the fibro-cartilaginous ligament of the metacarpal joints, and are of sufficient length to admit of a certain degree of movement between the ends of the metacarpal bones.

FIG. 62.

DIAGRAM OF THE FOUR DORSAL INTEROSSEI, DRAWING FROM THE MIDDLE LINE.

FIG. 63.

DIAGRAM OF THE THREE PALMAR INTEROSSEI, AND THE ADDUCTOR POLLICIS, DRAWING TOWARDS THE MIDDLE LINE.

DISSECTION. Remove the fascia which covers the interosseous muscles, and separate the metacarpal bones by dividing the transverse metacarpal ligament. A *bursa* is frequently developed between their digital extremities.

INTEROSSEOUS MUSCLES. These muscles, so named from their position, extend from the sides of the metacarpal bones to the bases of the first phalanges and the extensor tendons of the fingers. In each interosseous space (except the first, in which there is only an abductor) there are two muscles, one of which

is an abductor, the other an adductor, of a finger. Thus there are *seven* in all; four of which, situated on the back of the hand, are called dorsal; the remainder, seen only in the palm, are called palmar.* They are all supplied by the ulnar nerve.

DORSAL INTEROSSEI. Each dorsal interosseous muscle *arises* from the opposite sides of two contiguous metacarpal bones (fig. 62). From this double origin the fibres converge to a tendon, which passes between the metacarpal joints of the finger, and is *inserted* into the side of the base of the first phalanx, and by a broad expansion into the extensor tendon on the back of the same finger.

The *first* dorsal interosseous muscle (*abductor indicis*) is larger than the others, and occupies the interval between the thumb and fore-finger. It *arises* from the proximal half of the ulnar side of the first metacarpal bone, and from the entire length of the radial side of the second: between the two origins, the radial artery passes into the palm. Its fibres converge on either side to a tendon, which is *inserted* into the *radial* side of the first phalanx of the index finger and its extensor tendon.

The *second* dorsal interosseous muscle occupies the second metacarpal space. It is *inserted* into the radial side of the first phalanx of the middle finger and its extensor tendon.

The *third* and *fourth*, occupying the corresponding metacarpal spaces, are *inserted*, the one into the ulnar side of the middle, the other into the ulnar side of the ring finger.

If a line be drawn longitudinally through the middle finger, as represented by the dotted line in fig. 62, we find that all the dorsal interosseous muscles are abductors from that line; consequently, they separate the fingers from each other.

PALMAR INTEROSSEOUS. It requires a careful examination to distinguish this set of muscles, because the dorsal muscles protrude with them into the palm. They are smaller than the dorsal, and each *arises* from the lateral surface of only one metacarpal bone—that, namely, connected with the finger into which

* If we consider the adductor pollicis as a palmar interosseous muscle, there would be four palmar and four dorsal—all supplied by the ulnar nerve.

transverse metacarpal ligament. On the back of the hand the interosseous muscles are covered by a thin fascia, which is attached to the adjacent borders of the metacarpal bones.

TRANSVERSE METACARPAL LIGAMENT. This consists of strong bands of ligamentous fibres, which pass transversely between the distal extremities of the metacarpal bones. These bands are intimately united to the fibro-cartilaginous ligament of the metacarpal joints, and are of sufficient length to admit of a certain degree of movement between the ends of the metacarpal bones.

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FIG. 63.

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DISSECTION. Remove the fascia which covers the interosseous muscles, and separate the metacarpal bones by dividing the transverse metacarpal ligament. A *bursa* is frequently developed between their digital extremities.

INTEROSSEOUS MUSCLES. These muscles, so named from their position, extend from the sides of the metacarpal bones to the bases of the first phalanges and the extensor tendons of the fingers. In each interosseous space (except the first, in which there is only an abductor) there are two muscles, one of which

is an abductor, the other an adductor, of a finger. Thus there are *seven* in all; four of which, situated on the back of the hand, are called dorsal; the remainder, seen only in the palm, are called palmar.* They are all supplied by the ulnar nerve.

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The *second* dorsal interosseous muscle occupies the second metacarpal space. It is *inserted* into the radial side of the first phalanx of the middle finger and its extensor tendon.

The *third* and *fourth*, occupying the corresponding metacarpal spaces, are *inserted*, the one into the ulnar side of the middle, the other into the ulnar side of the ring finger.

If a line be drawn longitudinally through the middle finger, as represented by the dotted line in fig. 62, we find that all the dorsal interosseous muscles are abductors from that line; consequently, they separate the fingers from each other.

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* If we consider the adductor pollicis as a palmar interosseous muscle, there would be four palmar and four dorsal—all supplied by the ulnar nerve.

A little below the middle of the forearm, the extensors of the wrist and fingers diverge from each other, leaving an interval, in which are seen the three extensors of the thumb—namely, the extensor ossis metacarpi pollicis, the extensor primi internodii pollicis, and the extensor secundi internodii pollicis. The two former cross the radial extensors of the wrist, and pass over the lower third of the radius.

Between the second and third extensors of the thumb, we observe a part of the lower end of the radius, which is not covered either by muscle or tendon. This subcutaneous portion of the bone is immediately above the prominent tubercle in the middle of its lower extremity, and, since it can be easily felt through the skin, it presents a convenient place for examination in doubtful cases of fracture.

EXTENSOR CARPI RADIALIS LONGIOR. This muscle is partly covered by the supinator radii longus. It *arises* from the lower third of the ridge leading to the external condyle of the humerus, and from the intermuscular septum. It descends along the outer side of the forearm, and terminates about the middle, in a flat tendon, which passes beneath the extensor ossis metacarpi and primi internodii pollicis, traverses a groove on the outer and back part of the radius, lined by a synovial membrane, and is *inserted* into the radial side of the carpal end of the metacarpal bone of the index finger. Previous to its insertion, the tendon is crossed by the extensor secundi internodii pollicis. It is supplied by a branch from the musculo-spiral nerve.

EXTENSOR CARPI RADIALIS BREVIOR. This muscle *arises* from the external condyle by the tendon common to it and the other extensors, from the inter-muscular septa, and from the external lateral ligament of the elbow-joint. The muscular fibres terminate near the middle of the forearm, upon the under surface of a flat tendon, which descends, covered by that of the extensor carpi radialis longior, beneath the three extensors of the thumb. The tendon traverses a groove on the back of the radius, on the same plane with that of the long radial extensor, but lined by a separate synovial membrane, and is *inserted* into the radial

side of the metacarpal bone of the middle finger. A bursa is generally found between the tendon and the bone. Its nerve comes from the posterior interosseous.

EXTENSOR DIGITORUM COMMUNIS. This muscle *arises* from the common tendon attached to the external condyle, from the septa between it and the contiguous muscles, and from its strong fascial covering. About the middle of the forearm, the muscle divides into three or four fleshy slips, terminating in as many flat tendons, which pass beneath the posterior annular ligament, through a groove on the back of the radius lined by synovial membrane. On the back of the hand the tendons become broader and flatter, and diverge from each other towards the metacarpal joints of the fingers, where they become thicker and narrower, and give off, on each side, a fibrous expansion, which covers the sides of the joint. Over the first phalanx of the finger, each tendon again spreads out, receives the expanded tendons of the lumbricales and interossei muscles, and divides at the second phalanx into three portions, of which the middle is *inserted* into the upper end of the second phalanx; the two lateral, reuniting over the lower end of the second phalanx, are *inserted* into the upper end of the third.* Its nerve comes from the posterior interosseous.

The oblique aponeurotic slips which connect the tendons on the back of the hand are subject to great variety. The tendon of the index finger is commonly free; it is situated on the radial side of the proper indicator tendon, and becomes united with it at the metacarpal joint.

The tendon of the middle finger usually receives a slip from that of the ring. The tendon of the ring finger generally sends a slip to the tendons on either side of it, and, in some cases, entirely furnishes the tendon of the little finger. Thus the ring finger does not admit of independent extension.

* The extensor tendons are inserted into the periosteum; but the flexor tendons are inserted into the substance of the bone. This accounts for the facility with which the former will tear off the bones in cases of necrosis, while the latter will adhere so tightly as to require cutting before the phalanx can be removed. It probably also explains the great liability to necrosis which is so frequently observed in cases of thecal abscess.

The muscle is not only a general extensor of the fingers, but can extend some of the phalanges independently of the rest: *e.g.* it can extend the first phalanges while the second and third are flexed; or it can extend the second and third phalanges during flexion of the first.

EXTENSOR MINIMI DIGITI OR AURICULARIS. This long slender muscle, situated on the inner side of the common extensor, *arises* from the common tendon from the external condyle, and from the septa between it and the contiguous muscles. Its slender tendon runs separately beneath the annular ligament immediately behind the joint between the radius and ulna, in a special sheath lined by synovial membrane. At the first joint of the little finger, the tendon is joined by that of the common extensor, and both expand upon the first and second phalanges, terminating in the same manner as the extensor tendons of the other fingers. Its nerve comes from the posterior interosseous.

EXTENSOR CARPI ULNARIS. This muscle *arises* from the common tendon from the external condyle, from the septum between it and the extensor minimi digiti, and from the aponeurosis of the forearm. The fibres terminate upon a strong broad tendon, which traverses a distinct groove on the back of the ulna, close to the styloid process, and is *inserted* into the posterior aspect of the carpal end of the metacarpal bone of the little finger. Below the styloid process of the ulna, the tendon passes beneath the posterior annular ligament, over the back of the wrist, and is confined in a very strong fibrous canal, which is attached to the back of the cuneiform, pisiform, and unciform bones, and is lined by a continuation from the synovial membrane in the groove of the ulna. The *action* of this muscle is to extend the hand, and incline it towards the ulnar side. It is supplied by the posterior interosseous nerve.

In pronation of the forearm, the lower end of the ulna projects between the tendons of the extensor carpi ulnaris and the extensor minimi digiti. A subcutaneous *bursa* is sometimes found above the bone in this situation.

ANCONEUS. This small triangular muscle is situated at the outer and back part of the elbow. It is covered

by a strong layer of fascia, derived from the tendon of the triceps, and appears like a continuation of that muscle. It *arises* by a tendon from the posterior part of the external condyle of the humerus, and is *inserted* into the triangular surface on the upper fourth of the outer part of the ulna. Part of the under surface of the muscle is in contact with the capsule of the elbow-joint. Its *action* is to assist in extending the forearm. Its nerve comes from the musculo-spiral.

DISSECTION. To expose the deep layer of muscles, detach from the external condyle the extensor carpi radialis brevior, the extensor communis digitorum, the extensor minimi digiti, and the extensor carpi ulnaris; and, after noticing the vessels and nerves which enter their under surface, turn them down. The deep-seated muscles, with the posterior interosseous artery and nerve, must be dissected. The muscles exposed are:

DEEP-SEATED MUSCLES ON THE BACK OF THE FOREARM. 1. The extensor ossis metacarpi pollicis. 2. Extensor primi internodii pollicis. 3. Extensor secundi internodii pollicis. 4. Extensor indicis or indicator. 5. The supinator radii brevis. They are all supplied by branches from the posterior interosseous nerve.

EXTENSOR OSSIS METACARPI POLLICIS. This muscle *arises* from the posterior surface of the ulna below the supinator brevis, from the posterior surface of the radius, and from the interosseous membrane. The muscle crosses the radial extensors of the wrist about three inches above the carpus, and terminates in a tendon, which passes along a common groove with the extensor primi internodii pollicis, lined by synovial membrane, on the outer part of the lower end of the radius, and is *inserted* into the base of the metacarpal bone of the thumb, and frequently also by a tendinous slip into the trapezium.

EXTENSOR PRIMI INTERNODII POLLICIS. This small muscle *arises* from the posterior surface of the radius, below the preceding, and from the interosseous membrane. It descends obliquely in company with the preceding muscle, turns over the radial extensors of the wrist, and terminates upon a tendon which passes beneath the annular ligament, through the groove on the

outer part of the radius, and is *inserted* into the radial side of the base of the first phalanx of the thumb.

EXTENSOR SECUNDI INTERNODII POLLICIS. This muscle *arises* from the posterior surface of the ulna, below the last muscle, and from the interosseous membrane. The tendon receives fleshy fibres as low as the wrist, passes beneath the annular ligament, in a distinct groove on the back of the radius, crosses the tendons of the radial extensors of the wrist, proceeds over the metacarpal bone and the first phalanx of the thumb, and is *inserted* into the base of the last phalanx.

The tendons of the three extensors of the thumb may be easily distinguished in one's own hand. The extensor ossis metacarpi, and primi internodii pollicis, cross obliquely over the radial artery where it lies on the external lateral ligament of the carpus; the extensor secundi internodii pollicis crosses the artery just before it sinks into the palm, between the first and second metacarpal bones, and is a good guide to the vessel. The *action* of the three extensors of the thumb is implied by their names.

EXTENSOR INDICIS OR INDICATOR. This muscle *arises* from the posterior surface of the ulna, below the extensor secundi internodii pollicis. The tendon passes beneath the posterior annular ligament, in the same groove, on the back of the radius, with the tendons of the extensor digitorum communis. It then proceeds over the back of the hand to the first phalanx of the index finger, where it is united to the inner border of the common extensor tendon. By the *action* of this muscle the index finger can be extended independently of the others.

DISSECTION. Reflect the extensor carpi radialis brevior and the anconeus from their origins, to expose the following muscle.

SUPINATOR RADII BREVIS. This muscle embraces the upper third of the radius. It *arises* from the external lateral ligament of the elbow-joint, from the annular ligament surrounding the head of the radius, from an oblique ridge on the outer surface of the ulna below the insertion of the anconeus, and by fleshy fibres from the triangular excavation below the lesser sigmoid notch of

the ulna. The muscular fibres turn over the neck and upper part of the shaft of the radius, and are *inserted* into the upper third of this bone, as far forwards as the ridge leading from the tubercle to the insertion of the pronator teres. The muscle is traversed obliquely by the posterior interosseous nerve, which sends a branch to it, and its upper part is in contact with the capsule of the elbow-joint. It is a powerful supinator of the forearm, some of its fibres acting at nearly a right angle to the axis of the radius.

Posterior Interosseous Artery. This artery comes from the ulnar by a common trunk with the anterior interosseous (p. 296), and supplies the muscles on the back of the forearm. It passes between the oblique ligament and the interosseous membrane, and appears, at the back, between the supinator radii brevis and the extensor ossis metacarpi pollicis. After supplying branches to all the muscles in this situation, the artery descends, much diminished in size, between the superficial and deep layer of muscles to the wrist, where it inosculates with the carpal branches of the anterior interosseous, and the posterior carpal branches of the radial and ulnar arteries.

The largest branch of this artery is the *interosseous recurrent*. It ascends beneath the anconeus to the space between the external condyle and the olecranon, where it inosculates with the branch of the superior profunda, which descends in the substance of the triceps, and with the posterior ulnar recurrent artery.

In the lower part of the back of the forearm, a branch of the anterior interosseous artery is seen passing through the interosseous membrane to reach the back of the wrist.

Posterior Interosseous Nerve. The nerve which supplies the muscles on the back of the forearm is the *posterior interosseous*, one of the divisions of the musculo-spiral. It passes obliquely through the supinator radii brevis, and descends between the superficial and deep layer of muscles on the back of the forearm, sending to each a filament, generally in company with a branch of the posterior interosseous artery. It sends a branch to the extensor carpi radialis brevior, and supplies the supinator brevis in passing through its substance. The supinator radii longus and

the extensor carpi radialis longior are supplied by distinct branches from the musculo-spiral.

The continuation of the posterior interosseous nerve descends beneath the extensor secundi internodii pollicis and the tendons of the extensor digitorum communis to the back of the wrist. Behind

Fig. 61.

1. The superior profunda.
2. The anastomotica magna.
3. The posterior ulnar recurrent.
4. The posterior interosseous } its ascending and descending branches.
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DIAGRAM SHOWING THE ANASTOMOSES OF ARTERIES AT THE BACK OF THE ELBOW AND WRIST JOINTS.

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Dissection. Radial Artery on the Back of the Wrist.

The radial artery is continued over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, to the proximal part of the interval between the first and second metacarpal

bones, where it dips down between the two origins of the abductor indicis, and, entering the palm, forms the deep palmar arch. In this part of its course it is crossed by filaments of the radial nerve; observe, also, that the tendon of the extensor secundi internodii pollicis passes over it immediately before it sinks into the palm. It supplies the following small branches to the back of the hand:—

a. Posterior carpal artery.—This branch passes across the carpal bones, beneath the extensor tendons. It inosculates with the termination of the anterior interosseous artery, and forms an arch beneath the extensor tendons, with a corresponding branch from the ulnar artery. The carpal artery sends off small branches, called the *dorsal interosseous*, which descend along the third and fourth interosseous spaces from the arch just mentioned, beneath the extensor tendons, and inosculate near the carpal ends of the metacarpal bones with the perforating branches from the deep palmar arch.

b. The *first dorsal interosseous artery* is generally larger than the others. It passes towards the second interosseous space to the cleft between the index and middle fingers, communicating here with a perforating branch of the deep palmar arch, and terminates in small branches, some of which proceed along the back of the fingers, others inosculate with the palmar digital arteries.

c. The *dorsal artery of the index-finger*, a branch of variable size, passes over the first interosseous muscle to the radial side of the back of the index finger.

d. The *dorsal arteries of the thumb* are two small branches which arise from the radial opposite the head of the first metacarpal bone, and run along the back of the thumb, one on either side. They are often absent.

These dorsal interosseous arteries supply the extensor tendons and their sheaths, the interosseous muscles, and the skin on the back of the hand, and the first phalanges of the fingers.

DISSECTION. Remove the tendons from the back, and from the palm, of the hand: observe the deep palmar fascia which covers the interosseous muscles. It is attached to the ridges of the metacarpal bones, forms a distinct sheath for each interosseous muscle, and is continuous inferiorly with the

transverse metacarpal ligament. On the back of the hand the interosseous muscles are covered by a thin fascia, which is attached to the adjacent borders of the metacarpal bones.

TRANSVERSE METACARPAL LIGAMENT. This consists of strong bands of ligamentous fibres, which pass transversely between the distal extremities of the metacarpal bones. These bands are intimately united to the fibro-cartilaginous ligament of the metacarpal joints, and are of sufficient length to admit of a certain degree of movement between the ends of the metacarpal bones.

FIG. 62.

DIAGRAM OF THE FOUR DORSAL INTEROSSEI, DRAWING FROM THE MIDDLE LINE.

FIG. 63.

DIAGRAM OF THE THREE PALMAR INTEROSSEI, AND THE ADDUCTOR POLLICIS, DRAWING TOWARDS THE MIDDLE LINE.

DISSECTION. Remove the fascia which covers the interosseous muscles, and separate the metacarpal bones by dividing the transverse metacarpal ligament. A *bursa* is frequently developed between their digital extremities.

INTEROSSEOUS MUSCLES. These muscles, so named from their position, extend from the sides of the metacarpal bones to the bases of the first phalanges and the extensor tendons of the fingers. In each interosseous space (except the first, in which there is only an abductor) there are two muscles, one of which

is an abductor, the other an adductor, of a finger. Thus there are *seven* in all; four of which, situated on the back of the hand, are called dorsal; the remainder, seen only in the palm, are called palmar.* They are all supplied by the ulnar nerve.

DORSAL INTEROSSEI. Each dorsal interosseous muscle *arises* from the opposite sides of two contiguous metacarpal bones (fig. 62). From this double origin the fibres converge to a tendon, which passes between the metacarpal joints of the finger, and is *inserted* into the side of the base of the first phalanx, and by a broad expansion into the extensor tendon on the back of the same finger.

The *first* dorsal interosseous muscle (*abductor indicis*) is larger than the others, and occupies the interval between the thumb and fore-finger. It *arises* from the proximal half of the ulnar side of the first metacarpal bone, and from the entire length of the radial side of the second: between the two origins, the radial artery passes into the palm. Its fibres converge on either side to a tendon, which is *inserted* into the *radial* side of the first phalanx of the index finger and its extensor tendon.

The *second* dorsal interosseous muscle occupies the second metacarpal space. It is *inserted* into the radial side of the first phalanx of the middle finger and its extensor tendon.

The *third* and *fourth*, occupying the corresponding metacarpal spaces, are *inserted*, the one into the ulnar side of the middle, the other into the ulnar side of the ring finger.

If a line be drawn longitudinally through the middle finger, as represented by the dotted line in fig. 62, we find that all the dorsal interosseous muscles are abductors from that line; consequently, they separate the fingers from each other.

PALMAR INTEROSSEOUS. It requires a careful examination to distinguish this set of muscles, because the dorsal muscles protrude with them into the palm. They are smaller than the dorsal, and each *arises* from the lateral surface of only one metacarpal bone—that, namely, connected with the finger into which

* If we consider the adductor pollicis as a palmar interosseous muscle, there would be four palmar and four dorsal—all supplied by the ulnar nerve.

the muscle is inserted (fig. 63). They terminate in small tendons, which pass between the metacarpal joints of the fingers, and are *inserted*, like those of the dorsal muscles, into the sides of the first phalanges and the extensor tendons on the back of the fingers.

The *first* palmar interosseous muscle *arises* from the ulnar side of the second metacarpal bone, and is *inserted* into the ulnar side of the index finger. The *second* and *third* arise, the one from the radial side of the fourth, the other from the radial side of the fifth metacarpal bone, and are *inserted* into the same sides of the ring and little fingers.

The palmar interosseous muscles are all adductors to a line drawn through the middle finger (fig. 63). They are, therefore, the opponents of the dorsal interosseous, and move the fingers towards each other.

The palmar and dorsal interossei are supplied by filaments from the deep branch of the ulnar nerve.

DISSECTION OF THE LIGAMENTS.

STERNO-CLAVICULAR JOINT. The inner end of the clavicle articulates with the comparatively small and shallow excavation on the upper and outer part of the sternum. The security of the joint depends upon the great strength of its ligaments. There are two synovial membranes, and an intervening fibro-cartilage.

The *anterior sterno-clavicular ligament* (fig. 64) consists of a strong broad band of ligamentous fibres, which pass obliquely downwards and inwards over the front of the joint, from the inner end of the clavicle to the anterior surface of the sternum.

The *posterior sterno-clavicular ligament* extends over the back of the joint, from the back of the clavicle to the back of the sternum in a similar manner to the anterior.

The *inter-clavicular ligament* connects the clavicles directly. It extends transversely above the notch of the sternum, and has a broad attachment to the upper border of each clavicle. Between

the clavicles it is more or less attached to the sternum, so that it forms a curve with the concavity upwards.

The three ligaments just described are so closely connected that, collectively, they form for the joint a complete fibrous capsule of such strength that dislocation of it is rare.

The *costo-clavicular* or *rhomboid* ligament connects the clavicle to the cartilage of the first rib. It ascends obliquely outwards and backwards from the cartilage of the rib to a rough surface beneath the sternal end of the clavicle. Its use is to limit the elevation of the clavicle. There is such constant movement between the clavicle and the cartilage of the first rib that a well-marked *bursa* is commonly found between them.

FIG. 64.

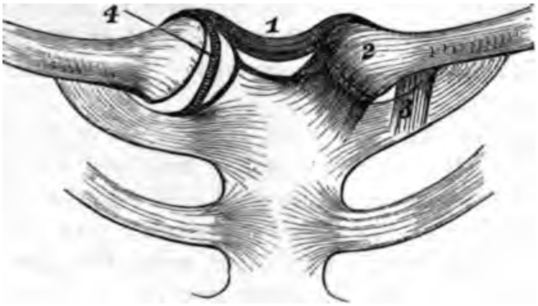


DIAGRAM OF THE STERNO-CLAVICULAR LIGAMENTS.

1. Inter-clavicular ligament.
2. Anterior sterno-clavicular ligament.
3. Costo-clavicular ligament.
4. Inter-articular fibro-cartilage.

Inter-articular fibro-cartilage.—To see this, cut through the rhomboid, the anterior and posterior ligaments of the joint, and raise the clavicle. It is nearly circular in form, and thicker at the circumference than the centre, in which there is sometimes a perforation. Inferiorly, it is attached to the cartilage of the first rib, close to the sternum; superiorly, to the upper part of the clavicle and the inter-clavicular ligament. Its circumference is inseparably connected with the anterior and posterior ligaments.

The joint is provided with two synovial membranes: one between the articular surface of the sternum and the inner surface

of the fibro-cartilage; the other between the articular surface of the clavicle and the outer surface of the fibro-cartilage.

This inter-articular fibro-cartilage is a structure highly elastic, without admitting of any stretching. It equalises pressure, breaks shocks, and also acts as a ligament, tending to prevent the clavicle from being driven inwards towards the mesial line.

Observe the relative form of the cartilaginous surfaces of the bones: that of the sternum is slightly concave in the transverse, and convex in the antero-posterior direction; that of the clavicle is the reverse.

The form of the articular surfaces and the ligaments of a joint being known, it is easy to understand the movements of which it is capable. The clavicle can be moved upon the sternum in a direction either vertical or horizontal: thus it admits of circumduction. These movements, though limited at the sternum, are considerable at the apex of the shoulder.

Scapulo-clavicular joint. The outer end of the clavicle articulates with the acromion, and is connected by strong ligaments to the coracoid process of the scapula.

The clavicle and the acromion articulate with each other by two flat oval cartilaginous surfaces, of which the planes slant inwards, and the longer diameters are in the antero-posterior direction.

The *superior ligament*, a broad band of ligamentous fibres, strengthened by the aponeurosis of the trapezius, extends from the upper surface of the acromion to the upper surface of the clavicle.

The *inferior ligament*, of less strength, extends along the under surface of the joint from bone to bone.

An *inter-articular fibro-cartilage* is sometimes found in this joint: but it is incomplete, and seldom extends lower than the upper half. There is only one synovial membrane.

Coraco-clavicular ligament.—The clavicle is connected to the coracoid process of the scapula by two strong ligaments—the *conoid* and *trapezoid*, which, being continuous with each other, should be considered as one. The *trapezoid* ligament is the more

anterior and external. It arises from the back part of the coracoid process, and ascends obliquely backwards and outwards to the clavicle, near its outer end. The *conoid* ligament is fixed at its apex to the root of the coracoid process, ascends nearly vertically, and is attached by its base to the clavicle. When the clavicle is fractured in the line of the attachment of the coraco-clavicular ligament, there is little or no displacement of the fractured ends, these being kept in place by the ligament.

LIGAMENTS OF THE SCAPULA. These are two: the transverse ligament, attached to the margins of the supra-scapular notch; and the *coraco-acromial* or *triangular* ligament, attached by its

FIG. 65.

1. Trapezoid } portions of the coraco-clavicular ligament.
2. Conoid
3. Supra-scapular or transverse ligament.
4. Coraco-acromial ligament.

5. Tendon of biceps.
6. Capsular ligament of the shoulder-joint.
7. Coraco-humeral ligament.
8. Foramen in the capsular ligament for the subscapularis tendon.

ANTERIOR VIEW OF THE SCAPULO-CLAVICULAR LIGAMENTS, AND OF THE SHOULDER-JOINT.

apex to the acromion, and by its base to the outer border of the coracoid process. It is separated from the upper part of the capsule of the shoulder-joint by a large *bursa*.

SHOULDER-JOINT. The articular surface of the head of the humerus, forming rather more than one-third of a sphere, moves upon the shallow glenoid cavity of the scapula, which is of an oval form, with the broader end downwards, and the long diameter nearly vertical. The security of the joint depends, not upon any mechanical contrivance of the bones, but upon the great strength and number of the tendons which surround and are intimately connected with it.

To admit the free motion of the head of the humerus upon the glenoid cavity, it is requisite that the *capsular ligament* of the joint be loose and capacious. Accordingly, the head of the bone, when detached from its muscular connections, may be separated from the glenoid cavity to the extent of an inch, or more, without laceration of the capsule. This explains the elongation of the arm observed in some cases in which effusion takes place into the joint; also in cases of paralysis of the deltoid.

The *capsular ligament* is attached above, round the circumference of the glenoid cavity; below, round the anatomical neck of the humerus. It is strongest on its upper aspect, weakest and longest on its lower. It is strengthened on its upper and posterior part by the tendons of the supra-spinatus, infra-spinatus, and teres minor; its inner part is strengthened by the broad tendon of the subscapularis, its lower part by the long head of the triceps.

Thus the circumference of the capsule is surrounded by tendons on every side, excepting a small space towards the axilla. If the humerus be raised, it will be found that the head of the bone rests upon this unprotected portion of the capsule, between the tendons of the subscapularis and the long head of the triceps: through this part of the capsule the head of the bone is first protruded in dislocations into the axilla.

At the upper and inner side of the joint, a small opening (*foramen ovale*) is observable in the capsular ligament, through which the tendon of the subscapularis passes, and comes in contact with the synovial membrane.

The upper surface of the capsule is strengthened by a strong band of ligamentous fibres, called the *coraco-humeral* or *accessory ligament*. It is attached to the root of the coracoid process, expands over the upper surface of the capsule, with which it is inseparably united, and is fixed into the greater tuberosity of the humerus.

Open the capsule to see the tendon of the long head of the biceps. It enters the joint through the groove between the two tuberosities, becomes slightly flattened, and passes over the head

of the bone to be attached to the upper border of the glenoid cavity. It is loose and movable within the joint. It acts like a strap, keeping down the head of the bone when the arm is raised by the deltoid.

The tendon of the biceps, strictly speaking, does not perforate the synovial membrane of the joint. It is inclosed in a tubular sheath, which is reflected over it at its attachment to the glenoid cavity, and accompanies it for two inches down the groove of the humerus. During the earlier part of fœtal life, it is connected to the capsule by a fold of synovial membrane, which subsequently disappears.

The margin of the glenoid cavity of the scapula is surrounded by a fibrous band of considerable thickness, called the *glenoid ligament.* This not only enlarges, but deepens the cavity. Superiorly, it is continuous on either side with the tendon of the biceps; inferiorly, with the tendon of the triceps: in the rest of its circumference it is attached to the edge of the cavity.

The cartilage covering the head of the humerus is thicker at the centre than at the circumference. The reverse is the case in the glenoid cavity.

The *synovial membrane* lining the under surface of the capsule is reflected around the tendon of the biceps, and passes with it in the form of a cul-de-sac down the bicipital groove. On the inner side of the joint it always communicates with the bursa beneath the tendon of the subscapularis.

The shoulder-joint has a more extensive range of motion than any other joint in the body; it is what mechanics call a universal joint. It is capable of motion forwards and backwards, of adduction, abduction, circumduction, and rotation.

ELBOW-JOINT.

The elbow-joint is a perfect hinge. The larger sigmoid cavity of the ulna is adapted to the trochlea upon the lower end of the humerus, admitting only of flexion and extension; while the shallow excavation upon the head of the radius admits not only of flexion and extension, but of rotation, upon the rounded articular eminence (*capitellum*) of the

humerus. The joint is secured by two strong lateral ligaments. No ligament is attached to the head of the radius, otherwise its rotatory movement would be impeded. The head is simply surrounded by a ligamentous collar, called the annular ligament, within which it freely rolls in pronation and supination of the hand.

Internal lateral ligament.—This is triangular, and is divided into two portions, an anterior and a posterior. Its anterior part is attached to the front of the internal condyle of the humerus:

Fig. 66.

a. External lateral ligament.
b. Orbicular or annular ligament.
c. Part of internal lateral ligament.
d. Radius, removed from the annular ligament.

LIGAMENTS OF THE ELBOW JOINT.

from this point the fibres radiate, and are inserted along the inner margin of the coronoid process of the ulna. The posterior part is also triangular, and passes from the back part of the internal condyle to the inner border of the olecranon.

A band of fibres extends transversely from the olecranon to the coronoid process, across a notch observable on the inner side of the sigmoid cavity: through this notch small vessels pass into the joint.

External lateral ligament.—This is attached to the external condyle of the humerus, and is in intimate connection with the

common tendon of the extensors. The fibres spread out as they descend, and are interwoven with the annular ligament, surrounding the head of the radius.

The *anterior* and *posterior* ligaments of the elbow-joint consist of a few thin ligamentous fibres, spread over the capsule of the joint, in front and behind. There is no need of ligaments to limit flexion and extension in this joint: the coronoid process limits the one; the olecranon the other.

The preceding ligaments, collectively, form a continuous capsule for the joint.

SUPERIOR RADIO-ULNAR ARTICULATION. The *orbicular* or *annular ligament of the radius* (fig. 66) does not of itself make a ring. Its ends are attached to the anterior and posterior borders of the lesser sigmoid cavity of the ulna. With this cavity it forms a complete collar, which encircles the head, and part of the neck, of the radius. The lower part of the ring is narrower than the upper, the better to clasp the neck of the radius, and maintain it more accurately in position. The external lateral ligament is attached to its outer surface.

Synovial membrane of the elbow-joint.—Open the joint by a transverse incision in front, and observe the relative adaptation of the cartilaginous surfaces of the bones. The synovial membrane lines the interior of the capsule, and forms a cul-de-sac between the head of the radius and its annular ligament. It is widest and loosest under the tendon of the triceps. Where the membrane is reflected from the bones upon the ligaments, there is more or less adipose tissue, particularly in the fossæ on the front and back part of the lower end of the humerus.

INTEROSSEOUS LIGAMENT OR MEMBRANE. This is an aponeurotic septum, stretched between the bones of the forearm, of which the chief purpose is to afford an increase of surface for the attachment of muscles. The septum is deficient above, to permit free rotation of the radius. Its fibres extend obliquely downwards from the radius to the ulna. It is perforated in its lower third by the anterior interosseous vessels.

The name of *round* or *oblique ligament* is given to a thin

band of fibres, which extends obliquely between the bones of the forearm in a direction contrary to those of the interosseous membrane. It is attached, superiorly, to the front surface of the ulna, near the outer side of the coronoid process; inferiorly, to the radius immediately below the tubercle. Between this ligament and the upper border of the interosseous membrane is a triangular interval through which the posterior interosseous artery passes to the back of the forearm. A *bursa* intervenes between the oblique ligament and the insertion of the tendon of the biceps. The use of this ligament is to limit supination of the radius.

RADIO-CARPAL OR WRIST-JOINT. This joint is formed by the lower end of the radius, which articulates with the scaphoid and semilunar bones of the carpus: the lower end of the ulna is excluded from the joint by a triangular fibro-cartilage, which articulates with a small portion of the cuneiform bone. The joint is secured by an anterior, a posterior, and two lateral ligaments.

The *external lateral ligament* extends from the styloid process of the radius to the scaphoid bone, to the anterior annular ligament, and to the trapezium.

The *internal lateral ligament* proceeds from the extremity of the styloid process of the ulna to the cuneiform bone. Some of its fibres are attached to the pisiform bone and the anterior annular ligament.

The *anterior ligament* consists of two or more broad bands of ligamentous fibres, which extend from the lower end of the radius to the first row of carpal bones.

The *posterior ligament*, weaker than the preceding, proceeds from the posterior surface of the lower end of the radius, and is attached to the posterior surfaces of the first row of carpal bones.

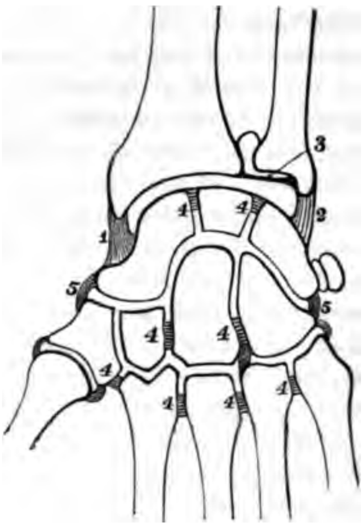
The *synovial membrane* lines the under surface of the triangular fibro-cartilage at the end of the ulna, is reflected over the several ligaments of the joint, and thence upon the first row of the carpal bones.

INFERIOR RADIO-ULNAR ARTICULATION. The inner surface of the lower end of the radius presents a slight concavity, which rotates upon the convex head of the ulna: this mechanism is

essential to the pronation and supination of the hand. These corresponding surfaces are covered with a thin layer of cartilage, and are provided with a very loose synovial membrane. The joint is strengthened in front and behind by thin transverse ligamentous fibres, which extend from the anterior and posterior borders of the sigmoid cavity of the radius to the anterior and posterior surfaces of the styloid process of the ulna. But the principal uniting medium between the bones is the following strong fibro-cartilage:—

FIG. 67.

1. External lateral ligament
2. Internal lateral ligament.
3. Interarticular fibro-cartilage between radius and ulna.



4. Interosseous ligaments.
5. Lateral ligaments of the intercarpal joint.

DIAGRAM OF THE LIGAMENTS AND SYNOVIAL MEMBRANES OF THE WRIST-JOINT.

Fibro-cartilage between the radius and ulna.—Saw through the bones of the forearm, and separate them by cutting through the interosseous membrane, and opening the synovial membrane of the joint between the lower ends. Thus a good view is obtained of the fibro-cartilage which connects them (fig. 67). It is triangular, and placed transversely at the lower end of the ulna, filling up the interval caused by the greater length of the radius. Its base is attached to the lower end of the radius; its apex to

of the fibro-cartilage; the other between the articular surface of the clavicle and the outer surface of the fibro-cartilage.

This inter-articular fibro-cartilage is a structure highly elastic, without admitting of any stretching. It equalises pressure, breaks shocks, and also acts as a ligament, tending to prevent the clavicle from being driven inwards towards the mesial line.

Observe the relative form of the cartilaginous surfaces of the bones: that of the sternum is slightly concave in the transverse, and convex in the antero-posterior direction; that of the clavicle is the reverse.

The form of the articular surfaces and the ligaments of a joint being known, it is easy to understand the movements of which it is capable. The clavicle can be moved upon the sternum in a direction either vertical or horizontal: thus it admits of circumduction. These movements, though limited at the sternum, are considerable at the apex of the shoulder.

SCAPULO-CLAVICULAR JOINT. The outer end of the clavicle articulates with the acromion, and is connected by strong ligaments to the coracoid process of the scapula.

The clavicle and the acromion articulate with each other by two flat oval cartilaginous surfaces, of which the planes slant inwards, and the longer diameters are in the antero-posterior direction.

The *superior ligament*, a broad band of ligamentous fibres, strengthened by the aponeurosis of the trapezius, extends from the upper surface of the acromion to the upper surface of the clavicle.

The *inferior ligament*, of less strength, extends along the under surface of the joint from bone to bone.

An *inter-articular fibro-cartilage* is sometimes found in this joint: but it is incomplete, and seldom extends lower than the upper half. There is only one synovial membrane.

Coraco-clavicular ligament.—The clavicle is connected to the coracoid process of the scapula by two strong ligaments—the *conoid* and *trapezoid*, which, being continuous with each other, should be considered as one. The *trapezoid* ligament is the more

anterior and external. It arises from the back part of the coracoid process, and ascends obliquely backwards and outwards to the clavicle, near its outer end. The *conoid* ligament is fixed at its apex to the root of the coracoid process, ascends nearly vertically, and is attached by its base to the clavicle. When the clavicle is fractured in the line of the attachment of the coraco-clavicular ligament, there is little or no displacement of the fractured ends, these being kept in place by the ligament.

LIGAMENTS OF THE SCAPULA. These are two: the transverse ligament, attached to the margins of the supra-scapular notch; and the *coraco-acromial* or *triangular* ligament, attached by its

FIG. 65.

1. Trapezoid } portions of the coraco-clavicular ligament.
2. Conoid } portions of the coraco-clavicular ligament.
3. Supra-scapular or transverse ligament.
4. Coraco-acromial ligament.

5. Tendon of biceps.
6. Capsular ligament of the shoulder-joint.
7. Coraco-humeral ligament.
8. Foramen in the capsular ligament for the subscapularis tendon.

ANTERIOR VIEW OF THE SCAPULO-CLAVICULAR LIGAMENTS, AND OF THE SHOULDER-JOINT.

apex to the acromion, and by its base to the outer border of the coracoid process. It is separated from the upper part of the capsule of the shoulder-joint by a large *bursa*.

SHOULDER-JOINT. The articular surface of the head of the humerus, forming rather more than one-third of a sphere, moves upon the shallow glenoid cavity of the scapula, which is of an oval form, with the broader end downwards, and the long diameter nearly vertical. The security of the joint depends, not upon any mechanical contrivance of the bones, but upon the great strength and number of the tendons which surround and are intimately connected with it.

To admit the free motion of the head of the humerus upon the glenoid cavity, it is requisite that the *capsular ligament* of the joint be loose and capacious. Accordingly, the head of the bone, when detached from its muscular connections, may be separated from the glenoid cavity to the extent of an inch, or more, without laceration of the capsule. This explains the elongation of the arm observed in some cases in which effusion takes place into the joint; also in cases of paralysis of the deltoid.

The *capsular ligament* is attached above, round the circumference of the glenoid cavity; below, round the anatomical neck of the humerus. It is strongest on its upper aspect, weakest and longest on its lower. It is strengthened on its upper and posterior part by the tendons of the supra-spinatus, infra-spinatus, and teres minor; its inner part is strengthened by the broad tendon of the subscapularis, its lower part by the long head of the triceps.

Thus the circumference of the capsule is surrounded by tendons on every side, excepting a small space towards the axilla. If the humerus be raised, it will be found that the head of the bone rests upon this unprotected portion of the capsule, between the tendons of the subscapularis and the long head of the triceps: through this part of the capsule the head of the bone is first protruded in dislocations into the axilla.

At the upper and inner side of the joint, a small opening (*foramen ovale*) is observable in the capsular ligament, through which the tendon of the subscapularis passes, and comes in contact with the synovial membrane.

The upper surface of the capsule is strengthened by a strong band of ligamentous fibres, called the *coraco-humeral* or *accessory ligament*. It is attached to the root of the coracoid process, expands over the upper surface of the capsule, with which it is inseparably united, and is fixed into the greater tuberosity of the humerus.

Open the capsule to see the tendon of the long head of the biceps. It enters the joint through the groove between the two tuberosities, becomes slightly flattened, and passes over the head

of the bone to be attached to the upper border of the glenoid cavity. It is loose and movable within the joint. It acts like a strap, keeping down the head of the bone when the arm is raised by the deltoid.

The tendon of the biceps, strictly speaking, does not perforate the synovial membrane of the joint. It is inclosed in a tubular sheath, which is reflected over it at its attachment to the glenoid cavity, and accompanies it for two inches down the groove of the humerus. During the earlier part of fœtal life, it is connected to the capsule by a fold of synovial membrane, which subsequently disappears.

The margin of the glenoid cavity of the scapula is surrounded by a fibrous band of considerable thickness, called the *glenoid ligament.* This not only enlarges, but deepens the cavity. Superiorly, it is continuous on either side with the tendon of the biceps; inferiorly, with the tendon of the triceps: in the rest of its circumference it is attached to the edge of the cavity.

The cartilage covering the head of the humerus is thicker at the centre than at the circumference. The reverse is the case in the glenoid cavity.

The *synovial membrane* lining the under surface of the capsule is reflected around the tendon of the biceps, and passes with it in the form of a cul-de-sac down the bicipital groove. On the inner side of the joint it always communicates with the bursa beneath the tendon of the subscapularis.

The shoulder-joint has a more extensive range of motion than any other joint in the body; it is what mechanics call a universal joint. It is capable of motion forwards and backwards, of adduction, abduction, circumduction, and rotation.

ELBOW-JOINT.

The elbow-joint is a perfect hinge. The larger sigmoid cavity of the ulna is adapted to the trochlea upon the lower end of the humerus, admitting only of flexion and extension; while the shallow excavation upon the head of the radius admits not only of flexion and extension, but of rotation, upon the rounded articular eminence (*capitellum*) of the

humerus. The joint is secured by two strong lateral ligaments. No ligament is attached to the head of the radius, otherwise its rotatory movement would be impeded. The head is simply surrounded by a ligamentous collar, called the annular ligament, within which it freely rolls in pronation and supination of the hand.

Internal lateral ligament.—This is triangular, and is divided into two portions, an anterior and a posterior. Its anterior part is attached to the front of the internal condyle of the humerus:

Fig. 66.

a. External lateral ligament.
b. Orbicular or annular ligament.

c. Part of internal lateral ligament.
d. Radius, removed from the annular ligament.

LIGAMENTS OF THE ELBOW JOINT.

from this point the fibres radiate, and are inserted along the inner margin of the coronoid process of the ulna. The posterior part is also triangular, and passes from the back part of the internal condyle to the inner border of the olecranon.

A band of fibres extends transversely from the olecranon to the coronoid process, across a notch observable on the inner side of the sigmoid cavity: through this notch small vessels pass into the joint.

External lateral ligament.—This is attached to the external condyle of the humerus, and is in intimate connection with the

common tendon of the extensors. The fibres spread out as they descend, and are interwoven with the annular ligament, surrounding the head of the radius.

The *anterior* and *posterior* ligaments of the elbow-joint consist of a few thin ligamentous fibres, spread over the capsule of the joint, in front and behind. There is no need of ligaments to limit flexion and extension in this joint: the coronoid process limits the one; the olecranon the other.

The preceding ligaments, collectively, form a continuous capsule for the joint.

SUPERIOR RADIO-ULNAR ARTICULATION. The *orbicular* or *annular ligament of the radius* (fig. 66) does not of itself make a ring. Its ends are attached to the anterior and posterior borders of the lesser sigmoid cavity of the ulna. With this cavity it forms a complete collar, which encircles the head, and part of the neck, of the radius. The lower part of the ring is narrower than the upper, the better to clasp the neck of the radius, and maintain it more accurately in position. The external lateral ligament is attached to its outer surface.

Synovial membrane of the elbow-joint.—Open the joint by a transverse incision in front, and observe the relative adaptation of the cartilaginous surfaces of the bones. The synovial membrane lines the interior of the capsule, and forms a cul-de-sac between the head of the radius and its annular ligament. It is widest and loosest under the tendon of the triceps. Where the membrane is reflected from the bones upon the ligaments, there is more or less adipose tissue, particularly in the fossæ on the front and back part of the lower end of the humerus.

INTEROSSEOUS LIGAMENT OR MEMBRANE. This is an aponeurotic septum, stretched between the bones of the forearm, of which the chief purpose is to afford an increase of surface for the attachment of muscles. The septum is deficient above, to permit free rotation of the radius. Its fibres extend obliquely downwards from the radius to the ulna. It is perforated in its lower third by the anterior interosseous vessels.

The name of *round* or *oblique ligament* is given to a thin

band of fibres, which extends obliquely between the bones of the forearm in a direction contrary to those of the interosseous membrane. It is attached, superiorly, to the front surface of the ulna, near the outer side of the coronoid process; inferiorly, to the radius immediately below the tubercle. Between this ligament and the upper border of the interosseous membrane is a triangular interval through which the posterior interosseous artery passes to the back of the forearm. A *bursa* intervenes between the oblique ligament and the insertion of the tendon of the biceps. The use of this ligament is to limit supination of the radius.

RADIO-CARPAL OR WRIST-JOINT. This joint is formed by the lower end of the radius, which articulates with the scaphoid and semilunar bones of the carpus: the lower end of the ulna is excluded from the joint by a triangular fibro-cartilage, which articulates with a small portion of the cuneiform bone. The joint is secured by an anterior, a posterior, and two lateral ligaments.

The *external lateral ligament* extends from the styloid process of the radius to the scaphoid bone, to the anterior annular ligament, and to the trapezium.

The *internal lateral ligament* proceeds from the extremity of the styloid process of the ulna to the cuneiform bone. Some of its fibres are attached to the pisiform bone and the anterior annular ligament.

The *anterior ligament* consists of two or more broad bands of ligamentous fibres, which extend from the lower end of the radius to the first row of carpal bones.

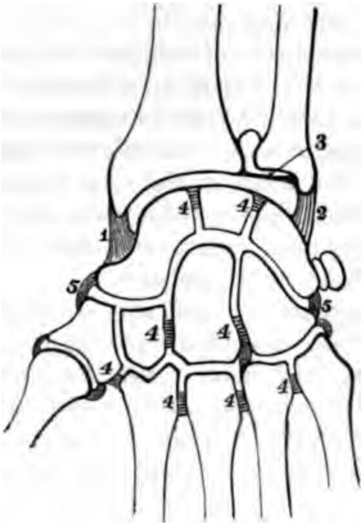
The *posterior ligament*, weaker than the preceding, proceeds from the posterior surface of the lower end of the radius, and is attached to the posterior surfaces of the first row of carpal bones.

The *synovial membrane* lines the under surface of the triangular fibro-cartilage at the end of the ulna, is reflected over the several ligaments of the joint, and thence upon the first row of the carpal bones.

INFERIOR RADIO-ULNAR ARTICULATION. The inner surface of the lower end of the radius presents a slight concavity, which rotates upon the convex head of the ulna: this mechanism is

essential to the pronation and supination of the hand. These corresponding surfaces are covered with a thin layer of cartilage, and are provided with a very loose synovial membrane. The joint is strengthened in front and behind by thin transverse ligamentous fibres, which extend from the anterior and posterior borders of the sigmoid cavity of the radius to the anterior and posterior surfaces of the styloid process of the ulna. But the principal uniting medium between the bones is the following strong fibro-cartilage:—

Fig. 67.



1. External lateral ligament
2. Internal lateral ligament.
3. Interarticular fibro-cartilage between radius and ulna.
4. Interosseous ligaments.
5. Lateral ligaments of the intercarpal joint.

DIAGRAM OF THE LIGAMENTS AND SYNOVIAL MEMBRANES OF THE WRIST-JOINT.

Fibro-cartilage between the radius and ulna.—Saw through the bones of the forearm, and separate them by cutting through the interosseous membrane, and opening the synovial membrane of the joint between the lower ends. Thus a good view is obtained of the fibro-cartilage which connects them (fig. 67). It is triangular, and placed transversely at the lower end of the ulna, filling up the interval caused by the greater length of the radius. Its base is attached to the lower end of the radius; its apex to

of the fibro-cartilage; the other between the articular surface of the clavicle and the outer surface of the fibro-cartilage.

This inter-articular fibro-cartilage is a structure highly elastic, without admitting of any stretching. It equalises pressure, breaks shocks, and also acts as a ligament, tending to prevent the clavicle from being driven inwards towards the mesial line.

Observe the relative form of the cartilaginous surfaces of the bones: that of the sternum is slightly concave in the transverse, and convex in the antero-posterior direction; that of the clavicle is the reverse.

The form of the articular surfaces and the ligaments of a joint being known, it is easy to understand the movements of which it is capable. The clavicle can be moved upon the sternum in a direction either vertical or horizontal: thus it admits of circumduction. These movements, though limited at the sternum, are considerable at the apex of the shoulder.

SCAPULO-CLAVICULAR JOINT.

The outer end of the clavicle articulates with the acromion, and is connected by strong ligaments to the coracoid process of the scapula.

The clavicle and the acromion articulate with each other by two flat oval cartilaginous surfaces, of which the planes slant inwards, and the longer diameters are in the antero-posterior direction.

The *superior ligament*, a broad band of ligamentous fibres, strengthened by the aponeurosis of the trapezius, extends from the upper surface of the acromion to the upper surface of the clavicle.

The *inferior ligament*, of less strength, extends along the under surface of the joint from bone to bone.

An *inter-articular fibro-cartilage* is sometimes found in this joint: but it is incomplete, and seldom extends lower than the upper half. There is only one synovial membrane.

Coraco-clavicular ligament.—The clavicle is connected to the coracoid process of the scapula by two strong ligaments—the *conoid* and *trapezoid*, which, being continuous with each other, should be considered as one. The *trapezoid* ligament is the more

anterior and external. It arises from the back part of the coracoid process, and ascends obliquely backwards and outwards to the clavicle, near its outer end. The *conoid* ligament is fixed at its apex to the root of the coracoid process, ascends nearly vertically, and is attached by its base to the clavicle. When the clavicle is fractured in the line of the attachment of the coraco-clavicular ligament, there is little or no displacement of the fractured ends, these being kept in place by the ligament.

LIGAMENTS OF THE SCAPULA. These are two: the transverse ligament, attached to the margins of the supra-scapular notch; and the *coraco-acromial* or *triangular* ligament, attached by its

FIG. 65.

1. Trapezoid } portions of the coraco-clavicular ligament.
2. Conoid
3. Supra-scapular or transverse ligament.
4. Coraco-acromial ligament.

5. Tendon of biceps.
6. Capsular ligament of the shoulder-joint.
7. Coraco-humeral ligament.
8. Foramen in the capsular ligament for the subscapularis tendon.

ANTERIOR VIEW OF THE SCAPULO-CLAVICULAR LIGAMENTS, AND OF THE SHOULDER-JOINT.

apex to the acromion, and by its base to the outer border of the coracoid process. It is separated from the upper part of the capsule of the shoulder-joint by a large *bursa.*

SHOULDER-JOINT. The articular surface of the head of the humerus, forming rather more than one-third of a sphere, moves upon the shallow glenoid cavity of the scapula, which is of an oval form, with the broader end downwards, and the long diameter nearly vertical. The security of the joint depends, not upon any mechanical contrivance of the bones, but upon the great strength and number of the tendons which surround and are intimately connected with it.

To admit the free motion of the head of the humerus upon the glenoid cavity, it is requisite that the *capsular ligament* of the joint be loose and capacious. Accordingly, the head of the bone, when detached from its muscular connections, may be separated from the glenoid cavity to the extent of an inch, or more, without laceration of the capsule. This explains the elongation of the arm observed in some cases in which effusion takes place into the joint; also in cases of paralysis of the deltoid.

The *capsular ligament* is attached above, round the circumference of the glenoid cavity; below, round the anatomical neck of the humerus. It is strongest on its upper aspect, weakest and longest on its lower. It is strengthened on its upper and posterior part by the tendons of the supra-spinatus, infra-spinatus, and teres minor; its inner part is strengthened by the broad tendon of the subscapularis, its lower part by the long head of the triceps.

Thus the circumference of the capsule is surrounded by tendons on every side, excepting a small space towards the axilla. If the humerus be raised, it will be found that the head of the bone rests upon this unprotected portion of the capsule, between the tendons of the subscapularis and the long head of the triceps: through this part of the capsule the head of the bone is first protruded in dislocations into the axilla.

At the upper and inner side of the joint, a small opening (*foramen ovale*) is observable in the capsular ligament, through which the tendon of the subscapularis passes, and comes in contact with the synovial membrane.

The upper surface of the capsule is strengthened by a strong band of ligamentous fibres, called the *coraco-humeral* or *accessory ligament*. It is attached to the root of the coracoid process, expands over the upper surface of the capsule, with which it is inseparably united, and is fixed into the greater tuberosity of the humerus.

Open the capsule to see the tendon of the long head of the biceps. It enters the joint through the groove between the two tuberosities, becomes slightly flattened, and passes over the head

of the bone to be attached to the upper border of the glenoid cavity. It is loose and movable within the joint. It acts like a strap, keeping down the head of the bone when the arm is raised by the deltoid.

The tendon of the biceps, strictly speaking, does not perforate the synovial membrane of the joint. It is inclosed in a tubular sheath, which is reflected over it at its attachment to the glenoid cavity, and accompanies it for two inches down the groove of the humerus. During the earlier part of fœtal life, it is connected to the capsule by a fold of synovial membrane, which subsequently disappears.

The margin of the glenoid cavity of the scapula is surrounded by a fibrous band of considerable thickness, called the *glenoid ligament*. This not only enlarges, but deepens the cavity. Superiorly, it is continuous on either side with the tendon of the biceps; inferiorly, with the tendon of the triceps: in the rest of its circumference it is attached to the edge of the cavity.

The cartilage covering the head of the humerus is thicker at the centre than at the circumference. The reverse is the case in the glenoid cavity.

The *synovial membrane* lining the under surface of the capsule is reflected around the tendon of the biceps, and passes with it in the form of a cul-de-sac down the bicipital groove. On the inner side of the joint it always communicates with the bursa beneath the tendon of the subscapularis.

The shoulder-joint has a more extensive range of motion than any other joint in the body; it is what mechanics call a universal joint. It is capable of motion forwards and backwards, of adduction, abduction, circumduction, and rotation.

ELBOW-JOINT. The elbow-joint is a perfect hinge. The larger sigmoid cavity of the ulna is adapted to the trochlea upon the lower end of the humerus, admitting only of flexion and extension; while the shallow excavation upon the head of the radius admits not only of flexion and extension, but of rotation, upon the rounded articular eminence (*capitellum*) of the

the extensor carpi radialis longior are supplied by distinct branches from the musculo-spiral.

The continuation of the posterior interosseous nerve descends beneath the extensor secundi internodii pollicis and the tendons of the extensor digitorum communis to the back of the wrist. Behind

Fig. 61.

1. The superior profunda.
2. The anastomotica magna.
3. The posterior ulnar recurrent.
4. The posterior interosseous } its ascending and descending branches.
5. The termination of the anterior interosseous.
6. The posterior carpal arch.

DIAGRAM SHOWING THE ANASTOMOSES OF ARTERIES AT THE BACK OF THE ELBOW AND WRIST JOINTS.

the common extensor tendons the nerve forms a gangliform enlargement from which filaments are sent to the carpal and metacarpal joints.

DISSECTION. RADIAL ARTERY ON THE BACK OF THE WRIST.

The radial artery is continued over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, to the proximal part of the interval between the first and second metacarpal

bones, where it dips down between the two origins of the abductor indicis, and, entering the palm, forms the deep palmar arch. In this part of its course it is crossed by filaments of the radial nerve; observe, also, that the tendon of the extensor secundi internodii pollicis passes over it immediately before it sinks into the palm. It supplies the following small branches to the back of the hand:—

a. Posterior carpal artery.—This branch passes across the carpal bones, beneath the extensor tendons. It inosculates with the termination of the anterior interosseous artery, and forms an arch beneath the extensor tendons, with a corresponding branch from the ulnar artery. The carpal artery sends off small branches, called the *dorsal interosseous*, which descend along the third and fourth interosseous spaces from the arch just mentioned, beneath the extensor tendons, and inosculate near the carpal ends of the metacarpal bones with the perforating branches from the deep palmar arch.

b. The *first dorsal interosseous artery* is generally larger than the others. It passes towards the second interosseous space to the cleft between the index and middle fingers, communicating here with a perforating branch of the deep palmar arch, and terminates in small branches, some of which proceed along the back of the fingers, others inosculate with the palmar digital arteries.

c. The *dorsal artery of the index-finger*, a branch of variable size, passes over the first interosseous muscle to the radial side of the back of the index finger.

d. The *dorsal arteries of the thumb* are two small branches which arise from the radial opposite the head of the first metacarpal bone, and run along the back of the thumb, one on either side. They are often absent.

These dorsal interosseous arteries supply the extensor tendons and their sheaths, the interosseous muscles, and the skin on the back of the hand, and the first phalanges of the fingers.

DISSECTION. Remove the tendons from the back, and from the palm, of the hand: observe the deep palmar fascia which covers the interosseous muscles. It is attached to the ridges of the metacarpal bones, forms a distinct sheath for each interosseous muscle, and is continuous inferiorly with the

transverse metacarpal ligament. On the back of the hand the interosseous muscles are covered by a thin fascia, which is attached to the adjacent borders of the metacarpal bones.

TRANSVERSE METACARPAL LIGAMENT. This consists of strong bands of ligamentous fibres, which pass transversely between the distal extremities of the metacarpal bones. These bands are intimately united to the fibro-cartilaginous ligament of the metacarpal joints, and are of sufficient length to admit of a certain degree of movement between the ends of the metacarpal bones.

FIG. 62.

DIAGRAM OF THE FOUR DORSAL INTEROSSEI, DRAWING FROM THE MIDDLE LINE.

FIG. 63.

DIAGRAM OF THE THREE PALMAR INTEROSSEI, AND THE ADDUCTOR POLLICIS, DRAWING TOWARDS THE MIDDLE LINE.

DISSECTION. Remove the fascia which covers the interosseous muscles, and separate the metacarpal bones by dividing the transverse metacarpal ligament. A *bursa* is frequently developed between their digital extremities.

INTEROSSEOUS MUSCLES. These muscles, so named from their position, extend from the sides of the metacarpal bones to the bases of the first phalanges and the extensor tendons of the fingers. In each interosseous space (except the first, in which there is only an abductor) there are two muscles, one of which

is an abductor, the other an adductor, of a finger. Thus there are *seven* in all; four of which, situated on the back of the hand, are called dorsal; the remainder, seen only in the palm, are called palmar.* They are all supplied by the ulnar nerve.

DORSAL INTEROSSEI. Each dorsal interosseous muscle *arises* from the opposite sides of two contiguous metacarpal bones (fig. 62). From this double origin the fibres converge to a tendon, which passes between the metacarpal joints of the finger, and is *inserted* into the side of the base of the first phalanx, and by a broad expansion into the extensor tendon on the back of the same finger.

The *first* dorsal interosseous muscle (*abductor indicis*) is larger than the others, and occupies the interval between the thumb and fore-finger. It *arises* from the proximal half of the ulnar side of the first metacarpal bone, and from the entire length of the radial side of the second: between the two origins, the radial artery passes into the palm. Its fibres converge on either side to a tendon, which is *inserted* into the *radial* side of the first phalanx of the index finger and its extensor tendon.

The *second* dorsal interosseous muscle occupies the second metacarpal space. It is *inserted* into the radial side of the first phalanx of the middle finger and its extensor tendon.

The *third* and *fourth*, occupying the corresponding metacarpal spaces, are *inserted*, the one into the ulnar side of the middle, the other into the ulnar side of the ring finger.

If a line be drawn longitudinally through the middle finger, as represented by the dotted line in fig. 62, we find that all the dorsal interosseous muscles are abductors from that line; consequently, they separate the fingers from each other.

PALMAR INTEROSSEOUS. It requires a careful examination to distinguish this set of muscles, because the dorsal muscles protrude with them into the palm. They are smaller than the dorsal, and each *arises* from the lateral surface of only one metacarpal bone—that, namely, connected with the finger into which

* If we consider the adductor pollicis as a palmar interosseous muscle, there would be four palmar and four dorsal—all supplied by the ulnar nerve.

the muscle is inserted (fig. 63). They terminate in small tendons, which pass between the metacarpal joints of the fingers, and are *inserted*, like those of the dorsal muscles, into the sides of the first phalanges and the extensor tendons on the back of the fingers.

The *first* palmar interosseous muscle *arises* from the ulnar side of the second metacarpal bone, and is *inserted* into the ulnar side of the index finger. The *second* and *third* arise, the one from the radial side of the fourth, the other from the radial side of the fifth metacarpal bone, and are *inserted* into the same sides of the ring and little fingers.

The palmar interosseous muscles are all adductors to a line drawn through the middle finger (fig. 63). They are, therefore, the opponents of the dorsal interosseous, and move the fingers towards each other.

The palmar and dorsal interossei are supplied by filaments from the deep branch of the ulnar nerve.

DISSECTION OF THE LIGAMENTS.

STERNO-CLAVICULAR JOINT. The inner end of the clavicle articulates with the comparatively small and shallow excavation on the upper and outer part of the sternum. The security of the joint depends upon the great strength of its ligaments. There are two synovial membranes, and an intervening fibro-cartilage.

The *anterior sterno-clavicular ligament* (fig. 64) consists of a strong broad band of ligamentous fibres, which pass obliquely downwards and inwards over the front of the joint, from the inner end of the clavicle to the anterior surface of the sternum.

The *posterior sterno-clavicular ligament* extends over the back of the joint, from the back of the clavicle to the back of the sternum in a similar manner to the anterior.

The *inter-clavicular ligament* connects the clavicles directly. It extends transversely above the notch of the sternum, and has a broad attachment to the upper border of each clavicle. Between

the clavicles it is more or less attached to the sternum, so that it forms a curve with the concavity upwards.

The three ligaments just described are so closely connected that, collectively, they form for the joint a complete fibrous capsule of such strength that dislocation of it is rare.

The *costo-clavicular* or *rhomboid* ligament connects the clavicle to the cartilage of the first rib. It ascends obliquely outwards and backwards from the cartilage of the rib to a rough surface beneath the sternal end of the clavicle. Its use is to limit the elevation of the clavicle. There is such constant movement between the clavicle and the cartilage of the first rib that a well-marked *bursa* is commonly found between them.

FIG. 64.

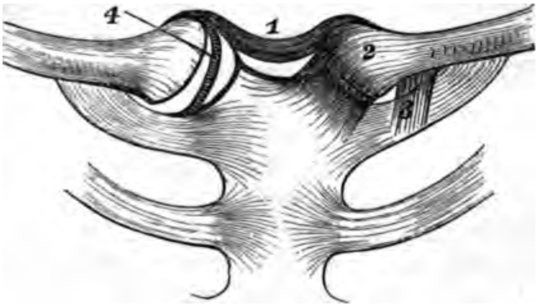


DIAGRAM OF THE STERNO-CLAVICULAR LIGAMENTS.

1. Inter-clavicular ligament.
2. Anterior sterno-clavicular ligament.
3. Costo-clavicular ligament.
4. Inter-articular fibro-cartilage.

Inter-articular fibro-cartilage.—To see this, cut through the rhomboid, the anterior and posterior ligaments of the joint, and raise the clavicle. It is nearly circular in form, and thicker at the circumference than the centre, in which there is sometimes a perforation. Inferiorly, it is attached to the cartilage of the first rib, close to the sternum; superiorly, to the upper part of the clavicle and the inter-clavicular ligament. Its circumference is inseparably connected with the anterior and posterior ligaments.

The joint is provided with two synovial membranes: one between the articular surface of the sternum and the inner surface

of the fibro-cartilage; the other between the articular surface of the clavicle and the outer surface of the fibro-cartilage.

This inter-articular fibro-cartilage is a structure highly elastic, without admitting of any stretching. It equalises pressure, breaks shocks, and also acts as a ligament, tending to prevent the clavicle from being driven inwards towards the mesial line.

Observe the relative form of the cartilaginous surfaces of the bones: that of the sternum is slightly concave in the transverse, and convex in the antero-posterior direction; that of the clavicle is the reverse.

The form of the articular surfaces and the ligaments of a joint being known, it is easy to understand the movements of which it is capable. The clavicle can be moved upon the sternum in a direction either vertical or horizontal: thus it admits of circumduction. These movements, though limited at the sternum, are considerable at the apex of the shoulder.

SCAPULO-CLAVICULAR JOINT. The outer end of the clavicle articulates with the acromion, and is connected by strong ligaments to the coracoid process of the scapula.

The clavicle and the acromion articulate with each other by two flat oval cartilaginous surfaces, of which the planes slant inwards, and the longer diameters are in the antero-posterior direction.

The *superior ligament*, a broad band of ligamentous fibres, strengthened by the aponeurosis of the trapezius, extends from the upper surface of the acromion to the upper surface of the clavicle.

The *inferior ligament*, of less strength, extends along the under surface of the joint from bone to bone.

An *inter-articular fibro-cartilage* is sometimes found in this joint: but it is incomplete, and seldom extends lower than the upper half. There is only one synovial membrane.

Coraco-clavicular ligament.—The clavicle is connected to the coracoid process of the scapula by two strong ligaments—the *conoid* and *trapezoid*, which, being continuous with each other, should be considered as one. The *trapezoid* ligament is the more

anterior and external. It arises from the back part of the coracoid process, and ascends obliquely backwards and outwards to the clavicle, near its outer end. The *conoid* ligament is fixed at its apex to the root of the coracoid process, ascends nearly vertically, and is attached by its base to the clavicle. When the clavicle is fractured in the line of the attachment of the coraco-clavicular ligament, there is little or no displacement of the fractured ends, these being kept in place by the ligament.

Ligaments of the Scapula. These are two: the transverse ligament, attached to the margins of the supra-scapular notch; and the *coraco-acromial* or *triangular* ligament, attached by its

Fig. 65.

1. Trapezoid } portions of the coraco-
2. Conoid } clavicular ligament.
3. Supra-scapular or transverse ligament.
4. Coraco-acromial ligament.

5. Tendon of biceps.
6. Capsular ligament of the shoulder-joint.
7. Coraco-humeral ligament.
8. Foramen in the capsular ligament for the subscapularis tendon.

ANTERIOR VIEW OF THE SCAPULO-CLAVICULAR LIGAMENTS, AND OF THE SHOULDER-JOINT.

apex to the acromion, and by its base to the outer border of the coracoid process. It is separated from the upper part of the capsule of the shoulder-joint by a large *bursa*.

Shoulder-joint. The articular surface of the head of the humerus, forming rather more than one-third of a sphere, moves upon the shallow glenoid cavity of the scapula, which is of an oval form, with the broader end downwards, and the long diameter nearly vertical. The security of the joint depends, not upon any mechanical contrivance of the bones, but upon the great strength and number of the tendons which surround and are intimately connected with it.

To admit the free motion of the head of the humerus upon the glenoid cavity, it is requisite that the *capsular ligament* of the joint be loose and capacious. Accordingly, the head of the bone, when detached from its muscular connections, may be separated from the glenoid cavity to the extent of an inch, or more, without laceration of the capsule. This explains the elongation of the arm observed in some cases in which effusion takes place into the joint; also in cases of paralysis of the deltoid.

The *capsular ligament* is attached above, round the circumference of the glenoid cavity; below, round the anatomical neck of the humerus. It is strongest on its upper aspect, weakest and longest on its lower. It is strengthened on its upper and posterior part by the tendons of the supra-spinatus, infra-spinatus, and teres minor; its inner part is strengthened by the broad tendon of the subscapularis, its lower part by the long head of the triceps.

Thus the circumference of the capsule is surrounded by tendons on every side, excepting a small space towards the axilla. If the humerus be raised, it will be found that the head of the bone rests upon this unprotected portion of the capsule, between the tendons of the subscapularis and the long head of the triceps: through this part of the capsule the head of the bone is first protruded in dislocations into the axilla.

At the upper and inner side of the joint, a small opening (*foramen ovale*) is observable in the capsular ligament, through which the tendon of the subscapularis passes, and comes in contact with the synovial membrane.

The upper surface of the capsule is strengthened by a strong band of ligamentous fibres, called the *coraco-humeral* or *accessory ligament*. It is attached to the root of the coracoid process, expands over the upper surface of the capsule, with which it is inseparably united, and is fixed into the greater tuberosity of the humerus.

Open the capsule to see the tendon of the long head of the biceps. It enters the joint through the groove between the two tuberosities, becomes slightly flattened, and passes over the head

of the bone to be attached to the upper border of the glenoid cavity. It is loose and movable within the joint. It acts like a strap, keeping down the head of the bone when the arm is raised by the deltoid.

The tendon of the biceps, strictly speaking, does not perforate the synovial membrane of the joint. It is inclosed in a tubular sheath, which is reflected over it at its attachment to the glenoid cavity, and accompanies it for two inches down the groove of the humerus. During the earlier part of fœtal life, it is connected to the capsule by a fold of synovial membrane, which subsequently disappears.

The margin of the glenoid cavity of the scapula is surrounded by a fibrous band of considerable thickness, called the *glenoid ligament.* This not only enlarges, but deepens the cavity. Superiorly, it is continuous on either side with the tendon of the biceps; inferiorly, with the tendon of the triceps: in the rest of its circumference it is attached to the edge of the cavity.

The cartilage covering the head of the humerus is thicker at the centre than at the circumference. The reverse is the case in the glenoid cavity.

The *synovial membrane* lining the under surface of the capsule is reflected around the tendon of the biceps, and passes with it in the form of a cul-de-sac down the bicipital groove. On the inner side of the joint it always communicates with the bursa beneath the tendon of the subscapularis.

The shoulder-joint has a more extensive range of motion than any other joint in the body; it is what mechanics call a universal joint. It is capable of motion forwards and backwards, of adduction, abduction, circumduction, and rotation.

ELBOW-JOINT.

The elbow-joint is a perfect hinge. The larger sigmoid cavity of the ulna is adapted to the trochlea upon the lower end of the humerus, admitting only of flexion and extension; while the shallow excavation upon the head of the radius admits not only of flexion and extension, but of rotation, upon the rounded articular eminence (*capitellum*) of the

humerus. The joint is secured by two strong lateral ligaments. No ligament is attached to the head of the radius, otherwise its rotatory movement would be impeded. The head is simply surrounded by a ligamentous collar, called the annular ligament, within which it freely rolls in pronation and supination of the hand.

Internal lateral ligament.—This is triangular, and is divided into two portions, an anterior and a posterior. Its anterior part is attached to the front of the internal condyle of the humerus:

Fig. 66.

a. External lateral ligament.
b. Orbicular or annular ligament.
c. Part of internal lateral ligament.
d. Radius, removed from the annular ligament.

LIGAMENTS OF THE ELBOW JOINT.

from this point the fibres radiate, and are inserted along the inner margin of the coronoid process of the ulna. The posterior part is also triangular, and passes from the back part of the internal condyle to the inner border of the olecranon.

A band of fibres extends transversely from the olecranon to the coronoid process, across a notch observable on the inner side of the sigmoid cavity: through this notch small vessels pass into the joint.

External lateral ligament.—This is attached to the external condyle of the humerus, and is in intimate connection with the

common tendon of the extensors. The fibres spread out as they descend, and are interwoven with the annular ligament, surrounding the head of the radius.

The *anterior* and *posterior* ligaments of the elbow-joint consist of a few thin ligamentous fibres, spread over the capsule of the joint, in front and behind. There is no need of ligaments to limit flexion and extension in this joint: the coronoid process limits the one; the olecranon the other.

The preceding ligaments, collectively, form a continuous capsule for the joint.

SUPERIOR RADIO-ULNAR ARTICULATION. The *orbicular* or *annular ligament of the radius* (fig. 66) does not of itself make a ring. Its ends are attached to the anterior and posterior borders of the lesser sigmoid cavity of the ulna. With this cavity it forms a complete collar, which encircles the head, and part of the neck, of the radius. The lower part of the ring is narrower than the upper, the better to clasp the neck of the radius, and maintain it more accurately in position. The external lateral ligament is attached to its outer surface.

Synovial membrane of the elbow-joint.—Open the joint by a transverse incision in front, and observe the relative adaptation of the cartilaginous surfaces of the bones. The synovial membrane lines the interior of the capsule, and forms a cul-de-sac between the head of the radius and its annular ligament. It is widest and loosest under the tendon of the triceps. Where the membrane is reflected from the bones upon the ligaments, there is more or less adipose tissue, particularly in the fossæ on the front and back part of the lower end of the humerus.

INTEROSSEOUS LIGAMENT OR MEMBRANE. This is an aponeurotic septum, stretched between the bones of the forearm, of which the chief purpose is to afford an increase of surface for the attachment of muscles. The septum is deficient above, to permit free rotation of the radius. Its fibres extend obliquely downwards from the radius to the ulna. It is perforated in its lower third by the anterior interosseous vessels.

The name of *round* or *oblique ligament* is given to a thin

band of fibres, which extends obliquely between the bones of the forearm in a direction contrary to those of the interosseous membrane. It is attached, superiorly, to the front surface of the ulna, near the outer side of the coronoid process; inferiorly, to the radius immediately below the tubercle. Between this ligament and the upper border of the interosseous membrane is a triangular interval through which the posterior interosseous artery passes to the back of the forearm. A *bursa* intervenes between the oblique ligament and the insertion of the tendon of the biceps. The use of this ligament is to limit supination of the radius.

RADIO-CARPAL OR WRIST-JOINT. This joint is formed by the lower end of the radius, which articulates with the scaphoid and semilunar bones of the carpus: the lower end of the ulna is excluded from the joint by a triangular fibro-cartilage, which articulates with a small portion of the cuneiform bone. The joint is secured by an anterior, a posterior, and two lateral ligaments.

The *external lateral ligament* extends from the styloid process of the radius to the scaphoid bone, to the anterior annular ligament, and to the trapezium.

The *internal lateral ligament* proceeds from the extremity of the styloid process of the ulna to the cuneiform bone. Some of its fibres are attached to the pisiform bone and the anterior annular ligament.

The *anterior ligament* consists of two or more broad bands of ligamentous fibres, which extend from the lower end of the radius to the first row of carpal bones.

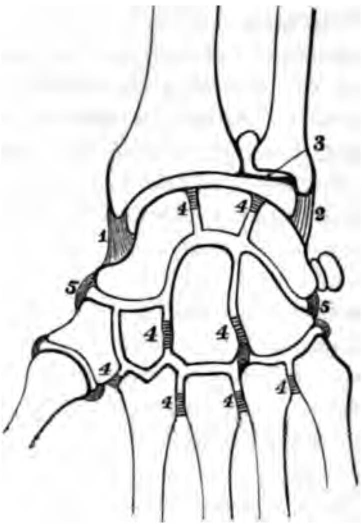
The *posterior ligament*, weaker than the preceding, proceeds from the posterior surface of the lower end of the radius, and is attached to the posterior surfaces of the first row of carpal bones.

The *synovial membrane* lines the under surface of the triangular fibro-cartilage at the end of the ulna, is reflected over the several ligaments of the joint, and thence upon the first row of the carpal bones.

INFERIOR RADIO-ULNAR ARTICULATION. The inner surface of the lower end of the radius presents a slight concavity, which rotates upon the convex head of the ulna: this mechanism is

essential to the pronation and supination of the hand. These corresponding surfaces are covered with a thin layer of cartilage, and are provided with a very loose synovial membrane. The joint is strengthened in front and behind by thin transverse ligamentous fibres, which extend from the anterior and posterior borders of the sigmoid cavity of the radius to the anterior and posterior surfaces of the styloid process of the ulna. But the principal uniting medium between the bones is the following strong fibro-cartilage:—

FIG. 67.



1. External lateral ligament
2. Internal lateral ligament.
3. Interarticular fibro-cartilage between radius and ulna.
4. Interosseous ligaments.
5. Lateral ligaments of the intercarpal joint.

DIAGRAM OF THE LIGAMENTS AND SYNOVIAL MEMBRANES OF THE WRIST-JOINT.

Fibro-cartilage between the radius and ulna.—Saw through the bones of the forearm, and separate them by cutting through the interosseous membrane, and opening the synovial membrane of the joint between the lower ends. Thus a good view is obtained of the fibro-cartilage which connects them (fig. 67). It is triangular, and placed transversely at the lower end of the ulna, filling up the interval caused by the greater length of the radius. Its base is attached to the lower end of the radius; its apex to

a depression at the root of the styloid process of the ulna. It is thin at the base and centre, thicker at the apex and sides. Its upper surface is in contact with the ulna, and covered by the synovial membrane of the radio-ulnar joint; its lower surface, forming a part of the wrist-joint, corresponds to the cuneiform bone. Its borders are connected with the anterior and posterior ligaments of the wrist. In some instances there is an aperture in the centre.

When, from accident or disease, this fibro-cartilage gets detached from the radius, the consequence is an abnormal projection of the lower end of the ulna.

The *synovial membrane* of this joint is distinct from that of the wrist, except in the case of a perforation through the fibro-cartilage. On account of its great looseness, necessary for the free rotation of the radius, it is called *membrana sacciformis*.

CARPAL JOINTS.

The bones of the carpus are arranged in two rows, an upper and a lower, adapted to each other, so as to form between them a joint, connected by anterior, posterior, internal, and external lateral ligaments.

The bones constituting each row are united by ligaments placed on their palmar and dorsal surfaces, and by others placed between the bones, and hence called interosseous. Their contiguous surfaces (those of the pisiform and cuneiform excepted) are covered by the reflections of one synovial membrane.

The *first row* is united by *dorsal* and *palmar transverse* ligaments proceeding from the scaphoid to the semilunar bone, and from the semilunar to the cuneiform; also by *interosseous* ligaments, proceeding from the semilunar to the bones on either side of it (fig. 67).

The *pisiform bone* is articulated to the palmar surface of the cuneiform bone, to which it is united by a fibrous capsule. Inferiorly it is attached by two strong ligaments, the one to the unciform bone, the other to the carpal end of the fifth metacarpal bone. This articulation has a distinct synovial membrane.

The *second row* of carpal bones is connected in the same way as the upper. The *dorsal* and *palmar* ligaments pass transversely

from one to the other. There are usually two interosseous ligaments, one on either side of the os magnum; sometimes there is a third, between the trapezium and trapezoid bones; they are thicker and stronger than those of the upper row, and unite the bones more firmly together.

INTERCARPAL JOINT. The upper row of carpal bones is arranged in the form of an arch, so as to receive the corresponding convex surfaces of the os magnum and unciforme. External to the os magnum, the trapezium and trapezoid bones present a slightly concave surface, which articulates with the scaphoid. In this way a joint admitting of flexion and extension only is formed between the upper and lower row. It is secured by *anterior*, *posterior*, and *two lateral* ligaments.

The *anterior* ligaments consist of strong ligamentous fibres, which pass obliquely from the bones of the upper to those of the lower row. The *posterior* ligaments consist of oblique and transverse fibres, which connect the dorsal surfaces of the bones of the upper with the lower row.

The *lateral* ligaments connect, externally, the scaphoid and trapezium; internally, the cuneiform and unciform bones.

Divide the ligaments, to see the manner in which the carpal bones articulate with each other. Their surfaces are crusted with cartilage, and have a common *synovial membrane*. This membrane extends, superiorly, between the three bones of the upper row, so as to form two culs-de-sac; inferiorly, it is prolonged into the joint between the carpal and the second and third metacarpal bones.

JOINT BETWEEN TRAPEZIUM AND THE FIRST METACARPAL BONE. The trapezium presents a cartilaginous surface, convex in the transverse, and concave in the antero-posterior direction (*i.e.* saddle-shaped), which articulates with the cartilaginous surface on the metacarpal bone of the thumb, concave and convex in the opposite directions. This peculiar adaptation of the two surfaces permits the several movements of the thumb—viz., flexion, extension, abduction and adduction; consequently circumduction. Thus we are enabled to oppose the thumb to all the fingers, which is one

of the great characteristics of the human hand. The joint is surrounded by a fibrous capsule sufficiently loose to admit free motion, and stronger on the dorsal than on the palmar aspect. The security of the joint is increased by the muscles which surround it. It has a separate synovial membrane.

CARPO-METACARPAL JOINTS.

The metacarpal bones of the fingers are connected to the second row of the carpal bones by ligaments upon their *palmar* and *dorsal* surfaces.

The *dorsal* ligaments are the stronger. The metacarpal bone of the fore-finger has two: one from the trapezium, the other from the trapezoid bone. That of the middle finger has also two, proceeding from the os magnum and the os trapezoides. That of the ring finger has also two, proceeding from the os magnum and the unciform bone. That of the little finger has one only, from the unciform bone.

The *palmar* ligaments are arranged nearly upon a similar plan. The metacarpal bone of the fore-finger has one from the trapezoid bone. That of the middle finger has three, proceeding from the trapezium, the os magnum, and the unciform bone. Those of the ring and little fingers have each one, from the unciform bone.

Besides the preceding ligaments, there is another of considerable strength, called the *interosseous*. It proceeds from the adjacent sides of the os magnum and the os unciforme, descends vertically, and is fixed into the radial side of the metacarpal bone of the ring finger (fig. 67). This ligament isolates the synovial membrane of the two inner metacarpal bones from the common synovial membrane of the carpus.

Separate the metacarpal bones from the carpus, and observe the relative form of their contiguous surfaces. The metacarpal bones of the fore and middle fingers are adapted to the carpus in such an angular manner as to be almost immovable. The metacarpal bone of the ring finger, having a plane articular surface with the unciform bone, admits of more motion. Still greater motion is permitted between the unciform and the metacarpal bone of the little finger, the articular surfaces of each being slightly concave and convex in opposite directions. The greater freedom of

motion of the metacarpal bone of the little finger is essential to the expansion and contraction of the palm.

The *carpal extremities of the metacarpal bones of the fingers* are connected with each other by transverse ligaments, both on their dorsal and their palmar surfaces. They are also connected by *interosseous* ligaments, which extend between the bones, immediately below their contiguous cartilaginous surfaces.

The *distal extremities* of these bones are loosely connected on their palmar aspect by the *transverse metacarpal* ligament.

SYNOVIAL MEMBRANES OF THE WRIST. There are six distinct synovial membranes, proper to the lower end of the radius, and the several bones of the carpus (see the diagram, p. 347) as follows:—

a. One between the lower end of the radius and the ulna.

b. One between the radius and the first row of carpal bones.

c. One between the trapezium and the metacarpal bone of the thumb.

d. One between the cuneiform and pisiform bones.

e. One between the first and second rows of carpal bones (the intercarpal joint). This extends to the metacarpal bones of the fore and middle fingers.

f. One between the unciform bone and the metacarpal bones of the little and ring fingers.

FIRST JOINT OF THE FINGERS. The first phalanx of the finger presents a shallow oval cavity, crusted with cartilage, with the broad diameter in the transverse direction, to articulate with the round cartilaginous head of the metacarpal bone, of which the articular surface is elongated in the antero-posterior direction, and of greater extent on its palmar than its dorsal aspect. This formation of parts permits flexion of the finger to a greater degree than extension; and also a slight lateral movement.

Each joint is provided with two strong *lateral* ligaments, and a *palmar*.

The *lateral* ligaments arise from the tubercles on either side of each metacarpal bone, and inclining slightly forward, are inserted into the sides of the base of the first phalanx of the finger.

The *palmar* ligament is a thick, compact, fibrous structure, which extends over the palmar surface of the joint. Its lower end is firmly attached to the base of the first phalanx of the finger; its upper end is loosely adherent to the rough surface above the head of the metacarpal bone. On either side it is inseparably connected with the lateral ligaments, so that with them it forms a strong capsule over the front and sides of the joint. Its superficial surface is slightly grooved, for the play of the flexor tendons; its deep surface is adapted to cover the head of the metacarpal bone. Two sesamoid bones are found in the palmar ligament belonging to the joint between the metacarpal bone and the first phalanx of the thumb.

The palmar ligaments have a surgical importance for the following reason:—In dislocation of the fingers, the facility of reduction mainly depends upon the extent to which the glenoid ligament is injured. If it be much torn there is but little difficulty: if entire, the reduction may require much manipulation.

These joints are secured on their dorsal aspect by the extensor tendon, and the expansion proceeding from it on either side. Their synovial membranes are loose, especially beneath the extensor tendons.

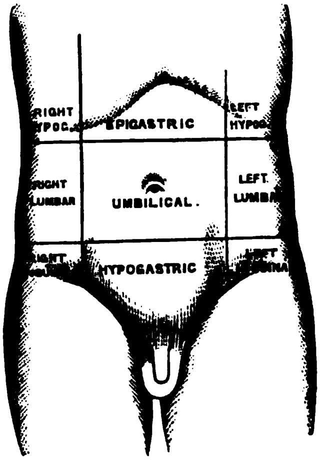
SECOND AND LAST JOINT OF THE FINGERS.

The corresponding articular surfaces of the phalanges of the fingers and thumb are so shaped as to form a hinge-joint, and, therefore, incapable of lateral movement. The ligaments connecting them are similar in every respect to those between the metacarpal bones and the first phalanges. The palmar ligament of the last joint of the thumb generally contains a sesamoid bone.

DISSECTION OF THE ABDOMEN.

Arbitrary Division into Regions. The abdomen is divided into arbitrary regions, that the situation of the viscera contained in it may be more easily described. For this purpose we draw the following lines:—one horizontally across the abdomen on a level with the cartilages of the ninth ribs; another on a level with the anterior superior spines of the ilia. These lines form the boundaries of three spaces, each of which is subdivided into three regions by a vertical line drawn on each side from the cartilage of the eighth rib to the middle of Poupart's ligament. Thus, there are a central and two lateral regions in each space. The central region of the upper space is termed the *epigastric*; the central one of the middle space is called the *umbilical* region; and the central of the inferior space, the *hypogastric* region. The lateral regions of the spaces from above downwards are termed the right and left *hypochondriac*, the right and left *lumbar*, and the right and left *inguinal* or *iliac* regions, respectively.

Fig. 68.



The abdomen should be distended with air, by means of a blowpipe inserted into the abdominal cavity at the umbilicus.

Dissection. An incision should be made from the sternum to the pubes, another from the anterior spine of the

humerus. The joint is secured by two strong lateral ligaments. No ligament is attached to the head of the radius, otherwise its rotatory movement would be impeded. The head is simply surrounded by a ligamentous collar, called the annular ligament, within which it freely rolls in pronation and supination of the hand.

Internal lateral ligament.—This is triangular, and is divided into two portions, an anterior and a posterior. Its anterior part is attached to the front of the internal condyle of the humerus:

Fig. 66.

a. External lateral ligament.
b. Orbicular or annular ligament.

c. Part of internal lateral ligament.
d. Radius, removed from the annular ligament.

LIGAMENTS OF THE ELBOW JOINT.

from this point the fibres radiate, and are inserted along the inner margin of the coronoid process of the ulna. The posterior part is also triangular, and passes from the back part of the internal condyle to the inner border of the olecranon.

A band of fibres extends transversely from the olecranon to the coronoid process, across a notch observable on the inner side of the sigmoid cavity: through this notch small vessels pass into the joint.

External lateral ligament.—This is attached to the external condyle of the humerus, and is in intimate connection with the

common tendon of the extensors. The fibres spread out as they descend, and are interwoven with the annular ligament, surrounding the head of the radius.

The *anterior* and *posterior* ligaments of the elbow-joint consist of a few thin ligamentous fibres, spread over the capsule of the joint, in front and behind. There is no need of ligaments to limit flexion and extension in this joint: the coronoid process limits the one; the olecranon the other.

The preceding ligaments, collectively, form a continuous capsule for the joint.

SUPERIOR RADIO-ULNAR ARTICULATION. The *orbicular* or *annular ligament of the radius* (fig. 66) does not of itself make a ring. Its ends are attached to the anterior and posterior borders of the lesser sigmoid cavity of the ulna. With this cavity it forms a complete collar, which encircles the head, and part of the neck, of the radius. The lower part of the ring is narrower than the upper, the better to clasp the neck of the radius, and maintain it more accurately in position. The external lateral ligament is attached to its outer surface.

Synovial membrane of the elbow-joint.—Open the joint by a transverse incision in front, and observe the relative adaptation of the cartilaginous surfaces of the bones. The synovial membrane lines the interior of the capsule, and forms a cul-de-sac between the head of the radius and its annular ligament. It is widest and loosest under the tendon of the triceps. Where the membrane is reflected from the bones upon the ligaments, there is more or less adipose tissue, particularly in the fossæ on the front and back part of the lower end of the humerus.

INTEROSSEOUS LIGAMENT OR MEMBRANE. This is an aponeurotic septum, stretched between the bones of the forearm, of which the chief purpose is to afford an increase of surface for the attachment of muscles. The septum is deficient above, to permit free rotation of the radius. Its fibres extend obliquely downwards from the radius to the ulna. It is perforated in its lower third by the anterior interosseous vessels.

The name of *round* or *oblique ligament* is given to a thin

band of fibres, which extends obliquely between the bones of the forearm in a direction contrary to those of the interosseous membrane. It is attached, superiorly, to the front surface of the ulna, near the outer side of the coronoid process; inferiorly, to the radius immediately below the tubercle. Between this ligament and the upper border of the interosseous membrane is a triangular interval through which the posterior interosseous artery passes to the back of the forearm. A *bursa* intervenes between the oblique ligament and the insertion of the tendon of the biceps. The use of this ligament is to limit supination of the radius.

RADIO-CARPAL OR WRIST-JOINT. This joint is formed by the lower end of the radius, which articulates with the scaphoid and semilunar bones of the carpus: the lower end of the ulna is excluded from the joint by a triangular fibro-cartilage, which articulates with a small portion of the cuneiform bone. The joint is secured by an anterior, a posterior, and two lateral ligaments.

The *external lateral ligament* extends from the styloid process of the radius to the scaphoid bone, to the anterior annular ligament, and to the trapezium.

The *internal lateral ligament* proceeds from the extremity of the styloid process of the ulna to the cuneiform bone. Some of its fibres are attached to the pisiform bone and the anterior annular ligament.

The *anterior ligament* consists of two or more broad bands of ligamentous fibres, which extend from the lower end of the radius to the first row of carpal bones.

The *posterior ligament*, weaker than the preceding, proceeds from the posterior surface of the lower end of the radius, and is attached to the posterior surfaces of the first row of carpal bones.

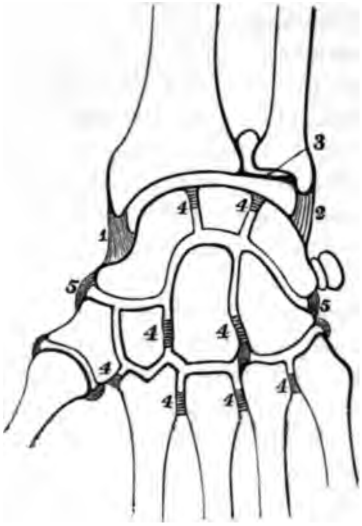
The *synovial membrane* lines the under surface of the triangular fibro-cartilage at the end of the ulna, is reflected over the several ligaments of the joint, and thence upon the first row of the carpal bones.

INFERIOR RADIO-ULNAR ARTICULATION. The inner surface of the lower end of the radius presents a slight concavity, which rotates upon the convex head of the ulna: this mechanism is

essential to the pronation and supination of the hand. These corresponding surfaces are covered with a thin layer of cartilage, and are provided with a very loose synovial membrane. The joint is strengthened in front and behind by thin transverse ligamentous fibres, which extend from the anterior and posterior borders of the sigmoid cavity of the radius to the anterior and posterior surfaces of the styloid process of the ulna. But the principal uniting medium between the bones is the following strong fibro-cartilage:—

FIG. 67.

1. External lateral ligament
2. Internal lateral ligament.
3. Interarticular fibro-cartilage between radius and ulna.



4. Interosseous ligaments.
5. Lateral ligaments of the intercarpal joint.

DIAGRAM OF THE LIGAMENTS AND SYNOVIAL MEMBRANES OF THE WRIST-JOINT.

Fibro-cartilage between the radius and ulna.—Saw through the bones of the forearm, and separate them by cutting through the interosseous membrane, and opening the synovial membrane of the joint between the lower ends. Thus a good view is obtained of the fibro-cartilage which connects them (fig. 67). It is triangular, and placed transversely at the lower end of the ulna, filling up the interval caused by the greater length of the radius. Its base is attached to the lower end of the radius; its apex to

a depression at the root of the styloid process of the ulna. It is thin at the base and centre, thicker at the apex and sides. Its upper surface is in contact with the ulna, and covered by the synovial membrane of the radio-ulnar joint; its lower surface, forming a part of the wrist-joint, corresponds to the cuneiform bone. Its borders are connected with the anterior and posterior ligaments of the wrist. In some instances there is an aperture in the centre.

When, from accident or disease, this fibro-cartilage gets detached from the radius, the consequence is an abnormal projection of the lower end of the ulna.

The *synovial membrane* of this joint is distinct from that of the wrist, except in the case of a perforation through the fibro-cartilage. On account of its great looseness, necessary for the free rotation of the radius, it is called *membrana sacciformis*.

CARPAL JOINTS. The bones of the carpus are arranged in two rows, an upper and a lower, adapted to each other, so as to form between them a joint, connected by anterior, posterior, internal, and external lateral ligaments.

The bones constituting each row are united by ligaments placed on their palmar and dorsal surfaces, and by others placed between the bones, and hence called interosseous. Their contiguous surfaces (those of the pisiform and cuneiform excepted) are covered by the reflections of one synovial membrane.

The *first row* is united by *dorsal* and *palmar transverse* ligaments proceeding from the scaphoid to the semilunar bone, and from the semilunar to the cuneiform; also by *interosseous* ligaments, proceeding from the semilunar to the bones on either side of it (fig. 67).

The *pisiform bone* is articulated to the palmar surface of the cuneiform bone, to which it is united by a fibrous capsule. Inferiorly it is attached by two strong ligaments, the one to the unciform bone, the other to the carpal end of the fifth metacarpal bone. This articulation has a distinct synovial membrane.

The *second row* of carpal bones is connected in the same way as the upper. The *dorsal* and *palmar* ligaments pass transversely

from one to the other. There are usually two interosseous ligaments, one on either side of the os magnum; sometimes there is a third, between the trapezium and trapezoid bones; they are thicker and stronger than those of the upper row, and unite the bones more firmly together.

INTERCARPAL JOINT. The upper row of carpal bones is arranged in the form of an arch, so as to receive the corresponding convex surfaces of the os magnum and unciforme. External to the os magnum, the trapezium and trapezoid bones present a slightly concave surface, which articulates with the scaphoid. In this way a joint admitting of flexion and extension only is formed between the upper and lower row. It is secured by *anterior*, *posterior*, and *two lateral* ligaments.

The *anterior* ligaments consist of strong ligamentous fibres, which pass obliquely from the bones of the upper to those of the lower row. The *posterior* ligaments consist of oblique and transverse fibres, which connect the dorsal surfaces of the bones of the upper with the lower row.

The *lateral* ligaments connect, externally, the scaphoid and trapezium; internally, the cuneiform and unciform bones.

Divide the ligaments, to see the manner in which the carpal bones articulate with each other. Their surfaces are crusted with cartilage, and have a common *synovial membrane*. This membrane extends, superiorly, between the three bones of the upper row, so as to form two culs-de-sac; inferiorly, it is prolonged into the joint between the carpal and the second and third metacarpal bones.

JOINT BETWEEN TRAPEZIUM AND THE FIRST METACARPAL BONE. The trapezium presents a cartilaginous surface, convex in the transverse, and concave in the antero-posterior direction (*i.e.* saddle-shaped), which articulates with the cartilaginous surface on the metacarpal bone of the thumb, concave and convex in the opposite directions. This peculiar adaptation of the two surfaces permits the several movements of the thumb—viz., flexion, extension, abduction and adduction; consequently circumduction. Thus we are enabled to oppose the thumb to all the fingers, which is one

of the great characteristics of the human hand. The joint is surrounded by a fibrous capsule sufficiently loose to admit free motion, and stronger on the dorsal than on the palmar aspect. The security of the joint is increased by the muscles which surround it. It has a separate synovial membrane.

CARPO-METACARPAL JOINTS.

The metacarpal bones of the fingers are connected to the second row of the carpal bones by ligaments upon their *palmar* and *dorsal* surfaces.

The *dorsal* ligaments are the stronger. The metacarpal bone of the fore-finger has two: one from the trapezium, the other from the trapezoid bone. That of the middle finger has also two, proceeding from the os magnum and the os trapezoides. That of the ring finger has also two, proceeding from the os magnum and the unciform bone. That of the little finger has one only, from the unciform bone.

The *palmar* ligaments are arranged nearly upon a similar plan. The metacarpal bone of the fore-finger has one from the trapezoid bone. That of the middle finger has three, proceeding from the trapezium, the os magnum, and the unciform bone. Those of the ring and little fingers have each one, from the unciform bone.

Besides the preceding ligaments, there is another of considerable strength, called the *interosseous*. It proceeds from the adjacent sides of the os magnum and the os unciforme, descends vertically, and is fixed into the radial side of the metacarpal bone of the ring finger (fig. 67). This ligament isolates the synovial membrane of the two inner metacarpal bones from the common synovial membrane of the carpus.

Separate the metacarpal bones from the carpus, and observe the relative form of their contiguous surfaces. The metacarpal bones of the fore and middle fingers are adapted to the carpus in such an angular manner as to be almost immovable. The metacarpal bone of the ring finger, having a plane articular surface with the unciform bone, admits of more motion. Still greater motion is permitted between the unciform and the metacarpal bone of the little finger, the articular surfaces of each being slightly concave and convex in opposite directions. The greater freedom of

motion of the metacarpal bone of the little finger is essential to the expansion and contraction of the palm.

The *carpal extremities of the metacarpal bones of the fingers* are connected with each other by transverse ligaments, both on their dorsal and their palmar surfaces. They are also connected by *interosseous* ligaments, which extend between the bones, immediately below their contiguous cartilaginous surfaces.

The *distal extremities* of these bones are loosely connected on their palmar aspect by the *transverse metacarpal* ligament.

SYNOVIAL MEMBRANES OF THE WRIST. There are six distinct synovial membranes, proper to the lower end of the radius, and the several bones of the carpus (see the diagram, p. 347) as follows:—

a. One between the lower end of the radius and the ulna.

b. One between the radius and the first row of carpal bones.

c. One between the trapezium and the metacarpal bone of the thumb.

d. One between the cuneiform and pisiform bones.

e. One between the first and second rows of carpal bones (the intercarpal joint). This extends to the metacarpal bones of the fore and middle fingers.

f. One between the unciform bone and the metacarpal bones of the little and ring fingers.

FIRST JOINT OF THE FINGERS. The first phalanx of the finger presents a shallow oval cavity, crusted with cartilage, with the broad diameter in the transverse direction, to articulate with the round cartilaginous head of the metacarpal bone, of which the articular surface is elongated in the antero-posterior direction, and of greater extent on its palmar than its dorsal aspect. This formation of parts permits flexion of the finger to a greater degree than extension; and also a slight lateral movement.

Each joint is provided with two strong *lateral* ligaments, and a *palmar.*

The *lateral* ligaments arise from the tubercles on either side of each metacarpal bone, and inclining slightly forward, are inserted into the sides of the base of the first phalanx of the finger.

The *palmar* ligament is a thick, compact, fibrous structure, which extends over the palmar surface of the joint. Its lower end is firmly attached to the base of the first phalanx of the finger; its upper end is loosely adherent to the rough surface above the head of the metacarpal bone. On either side it is inseparably connected with the lateral ligaments, so that with them it forms a strong capsule over the front and sides of the joint. Its superficial surface is slightly grooved, for the play of the flexor tendons; its deep surface is adapted to cover the head of the metacarpal bone. Two sesamoid bones are found in the palmar ligament belonging to the joint between the metacarpal bone and the first phalanx of the thumb.

The palmar ligaments have a surgical importance for the following reason:—In dislocation of the fingers, the facility of reduction mainly depends upon the extent to which the glenoid ligament is injured. If it be much torn there is but little difficulty: if entire, the reduction may require much manipulation.

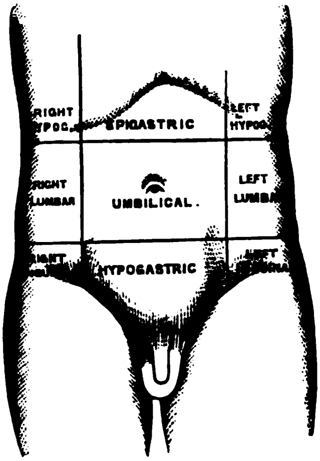
These joints are secured on their dorsal aspect by the extensor tendon, and the expansion proceeding from it on either side. Their synovial membranes are loose, especially beneath the extensor tendons.

Second and Last Joint of the Fingers. The corresponding articular surfaces of the phalanges of the fingers and thumb are so shaped as to form a hinge-joint, and, therefore, incapable of lateral movement. The ligaments connecting them are similar in every respect to those between the metacarpal bones and the first phalanges. The palmar ligament of the last joint of the thumb generally contains a sesamoid bone.

DISSECTION OF THE ABDOMEN.

Arbitrary Division into Regions. The abdomen is divided into arbitrary regions, that the situation of the viscera contained in it may be more easily described. For this purpose we draw the following lines:—one horizontally across the abdomen on a level with the cartilages of the ninth ribs; another on a level with the anterior superior spines of the ilia. These lines form the boundaries of three spaces, each of which is subdivided into three regions by a vertical line drawn on each side from the cartilage of the eighth rib to the middle of Poupart's ligament. Thus, there are a central and two lateral regions in each space. The central region of the upper space is termed the *epigastric*; the central one of the middle space is called the *umbilical* region; and the central of the inferior space, the *hypogastric* region. The lateral regions of the spaces from above downwards are termed the right and left *hypochondriac*, the right and left *lumbar*, and the right and left *inguinal* or *iliac* regions, respectively.

Fig. 68.



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Dissection. An incision should be made from the sternum to the pubes, another from the anterior spine of the

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SECOND AND LAST JOINT OF THE FINGERS.

The corresponding articular surfaces of the phalanges of the fingers and thumb are so shaped as to form a hinge-joint, and, therefore, incapable of lateral movement. The ligaments connecting them are similar in every respect to those between the metacarpal bones and the first phalanges. The palmar ligament of the last joint of the thumb generally contains a sesamoid bone.

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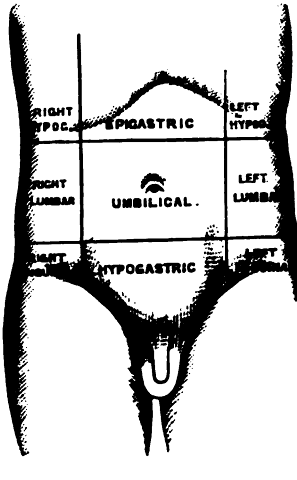


The abdomen should be distended with air, by means of a blowpipe inserted into the abdominal cavity at the umbilicus.

Dissection. An incision should be made from the sternum to the pubes, another from the anterior spine of the

humerus. The joint is secured by two strong lateral ligaments. No ligament is attached to the head of the radius, otherwise its rotatory movement would be impeded. The head is simply surrounded by a ligamentous collar, called the annular ligament, within which it freely rolls in pronation and supination of the hand.

Internal lateral ligament.—This is triangular, and is divided into two portions, an anterior and a posterior. Its anterior part is attached to the front of the internal condyle of the humerus:

FIG. 66.

a. External lateral ligament.
b. Orbicular or annular ligament.
c. Part of internal lateral ligament.
d. Radius, removed from the annular ligament.

LIGAMENTS OF THE ELBOW JOINT.

from this point the fibres radiate, and are inserted along the inner margin of the coronoid process of the ulna. The posterior part is also triangular, and passes from the back part of the internal condyle to the inner border of the olecranon.

A band of fibres extends transversely from the olecranon to the coronoid process, across a notch observable on the inner side of the sigmoid cavity: through this notch small vessels pass into the joint.

External lateral ligament.—This is attached to the external condyle of the humerus, and is in intimate connection with the

common tendon of the extensors. The fibres spread out as they descend, and are interwoven with the annular ligament, surrounding the head of the radius.

The *anterior* and *posterior* ligaments of the elbow-joint consist of a few thin ligamentous fibres, spread over the capsule of the joint, in front and behind. There is no need of ligaments to limit flexion and extension in this joint: the coronoid process limits the one; the olecranon the other.

The preceding ligaments, collectively, form a continuous capsule for the joint.

SUPERIOR RADIO-ULNAR ARTICULATION. The *orbicular* or *annular ligament of the radius* (fig. 66) does not of itself make a ring. Its ends are attached to the anterior and posterior borders of the lesser sigmoid cavity of the ulna. With this cavity it forms a complete collar, which encircles the head, and part of the neck, of the radius. The lower part of the ring is narrower than the upper, the better to clasp the neck of the radius, and maintain it more accurately in position. The external lateral ligament is attached to its outer surface.

Synovial membrane of the elbow-joint.—Open the joint by a transverse incision in front, and observe the relative adaptation of the cartilaginous surfaces of the bones. The synovial membrane lines the interior of the capsule, and forms a cul-de-sac between the head of the radius and its annular ligament. It is widest and loosest under the tendon of the triceps. Where the membrane is reflected from the bones upon the ligaments, there is more or less adipose tissue, particularly in the fossæ on the front and back part of the lower end of the humerus.

INTEROSSEOUS LIGAMENT OR MEMBRANE. This is an aponeurotic septum, stretched between the bones of the forearm, of which the chief purpose is to afford an increase of surface for the attachment of muscles. The septum is deficient above, to permit free rotation of the radius. Its fibres extend obliquely downwards from the radius to the ulna. It is perforated in its lower third by the anterior interosseous vessels.

The name of *round* or *oblique ligament* is given to a thin

band of fibres, which extends obliquely between the bones of the forearm in a direction contrary to those of the interosseous membrane. It is attached, superiorly, to the front surface of the ulna, near the outer side of the coronoid process; inferiorly, to the radius immediately below the tubercle. Between this ligament and the upper border of the interosseous membrane is a triangular interval through which the posterior interosseous artery passes to the back of the forearm. A *bursa* intervenes between the oblique ligament and the insertion of the tendon of the biceps. The use of this ligament is to limit supination of the radius.

RADIO-CARPAL OR WRIST-JOINT. This joint is formed by the lower end of the radius, which articulates with the scaphoid and semilunar bones of the carpus: the lower end of the ulna is excluded from the joint by a triangular fibro-cartilage, which articulates with a small portion of the cuneiform bone. The joint is secured by an anterior, a posterior, and two lateral ligaments.

The *external lateral ligament* extends from the styloid process of the radius to the scaphoid bone, to the anterior annular ligament, and to the trapezium.

The *internal lateral ligament* proceeds from the extremity of the styloid process of the ulna to the cuneiform bone. Some of its fibres are attached to the pisiform bone and the anterior annular ligament.

The *anterior ligament* consists of two or more broad bands of ligamentous fibres, which extend from the lower end of the radius to the first row of carpal bones.

The *posterior ligament*, weaker than the preceding, proceeds from the posterior surface of the lower end of the radius, and is attached to the posterior surfaces of the first row of carpal bones.

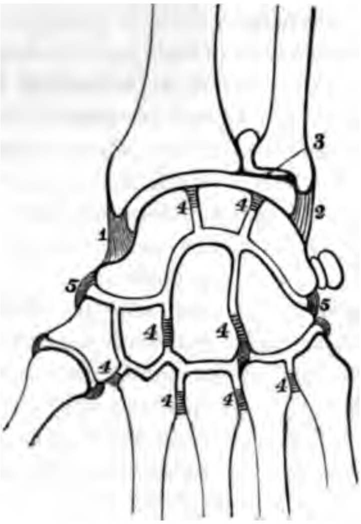
The *synovial membrane* lines the under surface of the triangular fibro-cartilage at the end of the ulna, is reflected over the several ligaments of the joint, and thence upon the first row of the carpal bones.

INFERIOR RADIO-ULNAR ARTICULATION. The inner surface of the lower end of the radius presents a slight concavity, which rotates upon the convex head of the ulna: this mechanism is

essential to the pronation and supination of the hand. These corresponding surfaces are covered with a thin layer of cartilage, and are provided with a very loose synovial membrane. The joint is strengthened in front and behind by thin transverse ligamentous fibres, which extend from the anterior and posterior borders of the sigmoid cavity of the radius to the anterior and posterior surfaces of the styloid process of the ulna. But the principal uniting medium between the bones is the following strong fibro-cartilage:—

FIG. 67.

1. External lateral ligament
2. Internal lateral ligament.
3. Interarticular fibro-cartilage between radius and ulna.



4. Interosseous ligaments.
5. Lateral ligaments of the intercarpal joint.

DIAGRAM OF THE LIGAMENTS AND SYNOVIAL MEMBRANES OF THE WRIST-JOINT.

Fibro-cartilage between the radius and ulna.—Saw through the bones of the forearm, and separate them by cutting through the interosseous membrane, and opening the synovial membrane of the joint between the lower ends. Thus a good view is obtained of the fibro-cartilage which connects them (fig. 67). It is triangular, and placed transversely at the lower end of the ulna, filling up the interval caused by the greater length of the radius. Its base is attached to the lower end of the radius; its apex to

a depression at the root of the styloid process of the ulna. It is thin at the base and centre, thicker at the apex and sides. Its upper surface is in contact with the ulna, and covered by the synovial membrane of the radio-ulnar joint; its lower surface, forming a part of the wrist-joint, corresponds to the cuneiform bone. Its borders are connected with the anterior and posterior ligaments of the wrist. In some instances there is an aperture in the centre.

When, from accident or disease, this fibro-cartilage gets detached from the radius, the consequence is an abnormal projection of the lower end of the ulna.

The *synovial membrane* of this joint is distinct from that of the wrist, except in the case of a perforation through the fibro-cartilage. On account of its great looseness, necessary for the free rotation of the radius, it is called *membrana sacciformis*.

CARPAL JOINTS. The bones of the carpus are arranged in two rows, an upper and a lower, adapted to each other, so as to form between them a joint, connected by anterior, posterior, internal, and external lateral ligaments.

The bones constituting each row are united by ligaments placed on their palmar and dorsal surfaces, and by others placed between the bones, and hence called interosseous. Their contiguous surfaces (those of the pisiform and cuneiform excepted) are covered by the reflections of one synovial membrane.

The *first row* is united by *dorsal* and *palmar transverse* ligaments proceeding from the scaphoid to the semilunar bone, and from the semilunar to the cuneiform; also by *interosseous* ligaments, proceeding from the semilunar to the bones on either side of it (fig. 67).

The *pisiform bone* is articulated to the palmar surface of the cuneiform bone, to which it is united by a fibrous capsule. Inferiorly it is attached by two strong ligaments, the one to the unciform bone, the other to the carpal end of the fifth metacarpal bone. This articulation has a distinct synovial membrane.

The *second row* of carpal bones is connected in the same way as the upper. The *dorsal* and *palmar* ligaments pass transversely

from one to the other. There are usually two interosseous ligaments, one on either side of the os magnum; sometimes there is a third, between the trapezium and trapezoid bones; they are thicker and stronger than those of the upper row, and unite the bones more firmly together.

INTERCARPAL JOINT. The upper row of carpal bones is arranged in the form of an arch, so as to receive the corresponding convex surfaces of the os magnum and unciforme. External to the os magnum, the trapezium and trapezoid bones present a slightly concave surface, which articulates with the scaphoid. In this way a joint admitting of flexion and extension only is formed between the upper and lower row. It is secured by *anterior*, *posterior*, and *two lateral* ligaments.

The *anterior* ligaments consist of strong ligamentous fibres, which pass obliquely from the bones of the upper to those of the lower row. The *posterior* ligaments consist of oblique and transverse fibres, which connect the dorsal surfaces of the bones of the upper with the lower row.

The *lateral* ligaments connect, externally, the scaphoid and trapezium; internally, the cuneiform and unciform bones.

Divide the ligaments, to see the manner in which the carpal bones articulate with each other. Their surfaces are crusted with cartilage, and have a common *synovial membrane*. This membrane extends, superiorly, between the three bones of the upper row, so as to form two culs-de-sac; inferiorly, it is prolonged into the joint between the carpal and the second and third metacarpal bones.

JOINT BETWEEN TRAPEZIUM AND THE FIRST METACARPAL BONE. The trapezium presents a cartilaginous surface, convex in the transverse, and concave in the antero-posterior direction (*i.e.* saddle-shaped), which articulates with the cartilaginous surface on the metacarpal bone of the thumb, concave and convex in the opposite directions. This peculiar adaptation of the two surfaces permits the several movements of the thumb—viz., flexion, extension, abduction and adduction; consequently circumduction. Thus we are enabled to oppose the thumb to all the fingers, which is one

of the great characteristics of the human hand. The joint is surrounded by a fibrous capsule sufficiently loose to admit free motion, and stronger on the dorsal than on the palmar aspect. The security of the joint is increased by the muscles which surround it. It has a separate synovial membrane.

CARPO-METACARPAL JOINTS.

The metacarpal bones of the fingers are connected to the second row of the carpal bones by ligaments upon their *palmar* and *dorsal* surfaces.

The *dorsal* ligaments are the stronger. The metacarpal bone of the fore-finger has two: one from the trapezium, the other from the trapezoid bone. That of the middle finger has also two, proceeding from the os magnum and the os trapezoides. That of the ring finger has also two, proceeding from the os magnum and the unciform bone. That of the little finger has one only, from the unciform bone.

The *palmar* ligaments are arranged nearly upon a similar plan. The metacarpal bone of the fore-finger has one from the trapezoid bone. That of the middle finger has three, proceeding from the trapezium, the os magnum, and the unciform bone. Those of the ring and little fingers have each one, from the unciform bone.

Besides the preceding ligaments, there is another of considerable strength, called the *interosseous*. It proceeds from the adjacent sides of the os magnum and the os unciforme, descends vertically, and is fixed into the radial side of the metacarpal bone of the ring finger (fig. 67). This ligament isolates the synovial membrane of the two inner metacarpal bones from the common synovial membrane of the carpus.

Separate the metacarpal bones from the carpus, and observe the relative form of their contiguous surfaces. The metacarpal bones of the fore and middle fingers are adapted to the carpus in such an angular manner as to be almost immovable. The metacarpal bone of the ring finger, having a plane articular surface with the unciform bone, admits of more motion. Still greater motion is permitted between the unciform and the metacarpal bone of the little finger, the articular surfaces of each being slightly concave and convex in opposite directions. The greater freedom of

motion of the metacarpal bone of the little finger is essential to the expansion and contraction of the palm.

The *carpal extremities of the metacarpal bones of the fingers* are connected with each other by transverse ligaments, both on their dorsal and their palmar surfaces. They are also connected by *interosseous* ligaments, which extend between the bones, immediately below their contiguous cartilaginous surfaces.

The *distal extremities* of these bones are loosely connected on their palmar aspect by the *transverse metacarpal* ligament.

SYNOVIAL MEMBRANES OF THE WRIST.

There are six distinct synovial membranes, proper to the lower end of the radius, and the several bones of the carpus (see the diagram, p. 347) as follows:—

a. One between the lower end of the radius and the ulna.
b. One between the radius and the first row of carpal bones.
c. One between the trapezium and the metacarpal bone of the thumb.
d. One between the cuneiform and pisiform bones.
e. One between the first and second rows of carpal bones (the intercarpal joint). This extends to the metacarpal bones of the fore and middle fingers.
f. One between the unciform bone and the metacarpal bones of the little and ring fingers.

FIRST JOINT OF THE FINGERS.

The first phalanx of the finger presents a shallow oval cavity, crusted with cartilage, with the broad diameter in the transverse direction, to articulate with the round cartilaginous head of the metacarpal bone, of which the articular surface is elongated in the antero-posterior direction, and of greater extent on its palmar than its dorsal aspect. This formation of parts permits flexion of the finger to a greater degree than extension; and also a slight lateral movement.

Each joint is provided with two strong *lateral* ligaments, and a *palmar.*

The *lateral* ligaments arise from the tubercles on either side of each metacarpal bone, and inclining slightly forward, are inserted into the sides of the base of the first phalanx of the finger.

The *palmar* ligament is a thick, compact, fibrous structure, which extends over the palmar surface of the joint. Its lower end is firmly attached to the base of the first phalanx of the finger; its upper end is loosely adherent to the rough surface above the head of the metacarpal bone. On either side it is inseparably connected with the lateral ligaments, so that with them it forms a strong capsule over the front and sides of the joint. Its superficial surface is slightly grooved, for the play of the flexor tendons; its deep surface is adapted to cover the head of the metacarpal bone. Two sesamoid bones are found in the palmar ligament belonging to the joint between the metacarpal bone and the first phalanx of the thumb.

The palmar ligaments have a surgical importance for the following reason:—In dislocation of the fingers, the facility of reduction mainly depends upon the extent to which the glenoid ligament is injured. If it be much torn there is but little difficulty: if entire, the reduction may require much manipulation.

These joints are secured on their dorsal aspect by the extensor tendon, and the expansion proceeding from it on either side. Their synovial membranes are loose, especially beneath the extensor tendons.

SECOND AND LAST JOINT OF THE FINGERS.

The corresponding articular surfaces of the phalanges of the fingers and thumb are so shaped as to form a hinge-joint, and, therefore, incapable of lateral movement. The ligaments connecting them are similar in every respect to those between the metacarpal bones and the first phalanges. The palmar ligament of the last joint of the thumb generally contains a sesamoid bone.

DISSECTION OF THE ABDOMEN.

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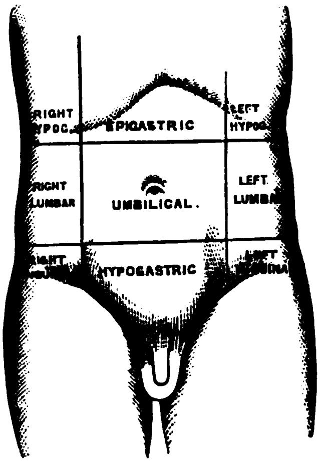
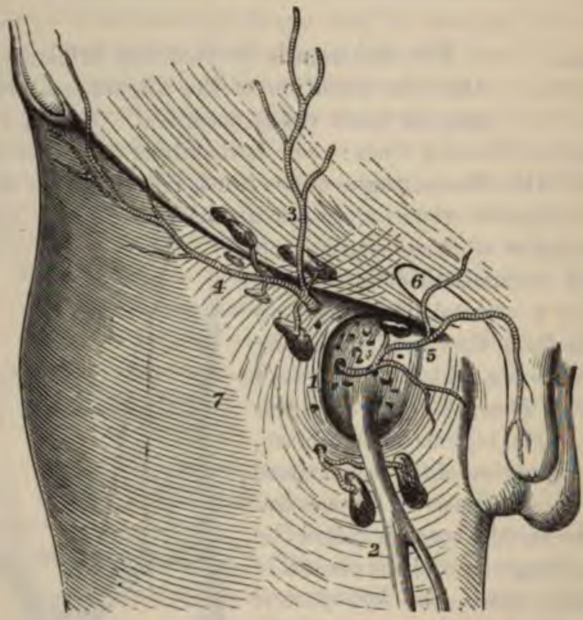


The abdomen should be distended with air, by means of a blowpipe inserted into the abdominal cavity at the umbilicus.

Dissection. An incision should be made from the sternum to the pubes, another from the anterior spine of the

ilium to a point midway between the umbilicus and pubes, and a third from the ensiform cartilage, transversely outwards towards the axilla as far as the angles of the ribs. The skin should then be dissected from the subjacent adipose and connective tissue, called the superficial fascia.

Fig. 69.



SUPERFICIAL VESSELS AND GLANDS OF THE GROIN.

1. Saphenous opening of the fascia lata.
2. Saphena vein.
3. Superficial epigastric a.
4. Superficial circumflexa ilii a.
5. Superficial pudic a.
6. External abdominal ring.
7. Fascia lata of the thigh.

Superficial Fascia. The subcutaneous tissue of the abdomen has the same general characters as that of other parts, and varies in thickness in different persons, according to the amount of fat. At the lower part of the abdomen, it admits of separation into two layers, between which are found the sub-

cutaneous blood-vessels, the lymphatic glands, the ilio-inguinal nerve, and the hypogastric branch of the ilio-hypogastric nerve.

Respecting the superficial layer, observe that it contains the fat, and is continuous with the superficial fascia of the thigh, the scrotum, and the perineum. The deeper layer is intimately connected with Poupart's ligament and the linea alba; but it is very loosely continued over the spermatic cord and the scrotum, and becomes identified with the deep layer of the superficial fascia of the perineum. These points deserve attention, since they explain how urine, extravasated into the perineum and scrotum, readily makes its way over the spermatic cord on to the surface of the abdomen; but from this it cannot travel down the thigh, on account of the connection of the fascia with Poupart's ligament.

SUPERFICIAL BLOOD-VESSELS AND LYMPHATIC GLANDS.

Between the layers of the superficial fascia on the groin and upper part of the thigh, are several lymphatic glands and small blood-vessels (fig. 69). The glands are named, according to their situation, inguinal or femoral. The inguinal, from three to four in number, are often small, and escape observation. They are of an oval form, with their long axis corresponding to the line of the crural arch (represented by the dark line in fig. 69). They receive the superficial lymphatics from the lower part of the wall of the abdomen, from the scrotum, penis, perineum, anus, and gluteal region, and are therefore generally affected in venereal disease. The lymphatics from the upper part of the abdominal parietes terminate in the lumbar glands.

The *superficial arteries* in the neighbourhood arise from the femoral. One, the *superficial epigastric*, ascends over Poupart's ligament and ramifies over the lower part of the abdomen, as high as the umbilicus, inosculating with the deep epigastric artery; another, the *superficial external pudic*, crosses the spermatic cord, and is distributed to the skin of the penis and scrotum; a third, the *superficial circumflexa ilii*, ramifies towards the spine of the ilium. These subcutaneous arteries, the pudic especially, often occasion a free hæmorrhage in the operation for strangulated hernia.

The corresponding *veins* join the saphena vein of the thigh. Under ordinary circumstances they do not appear in the living subject; but when any obstruction occurs in the inferior vena cava, they become enlarged and tortuous, and constitute the chief channels through which the blood would be returned from the lower limbs.*

CUTANEOUS NERVES. The skin of the abdomen is supplied with nerves after the same plan as the chest: namely, by lateral and anterior branches derived from the five or six lower intercostal nerves, as follows:—

a. The *lateral cutaneous nerves* come out between the digitations of the external oblique muscle, in company with small arteries, and divide into anterior and posterior branches; the anterior supply the skin as far as the rectus; the posterior, the skin over the latissimus dorsi. The lateral branch of the twelfth dorsal nerve is larger than the others, and passes over the crest of the ilium to the skin of the buttock, without dividing like the other nerves. The corresponding branch of the first lumbar has a similar distribution.

b. The *anterior cutaneous nerves* emerge with small arteries through the sheath of the rectus. They are not only smaller than the lateral nerves, but their number and place of exit is less regular. That which comes through the external abdominal ring (*ilio-inguinal*), as well as that which comes through the wall of the abdomen just above it (the *hypogastric* branch of the *ilio-hypogastric*), are derived from the first lumbar nerve. These, however, are but repetitions of the others, and supply the skin of the groin and scrotum in the male, and the labium pudendi in the female.

A small nerve—namely, the *genital* branch of the genito-crural—comes through the external ring. It lies behind the cord close to the outer pillar.

DISSECTION. The deep layer of the superficial fascia should now be removed from the external oblique, by commencing at the

* A cast in illustration of this is preserved in the Museum of St. Bartholomew's Hospital.

fleshy portion of the muscle, and working in the course of its fibres. Care must be taken not to remove any of its aponeurosis, which is very thin. The digitations of this muscle with the serratus magnus and latissimus dorsi must also be made out.

MUSCLES OF THE ABDOMINAL WALL. The abdominal muscles, three on each side, are arranged in strata, named, after the direction of their fibres, the external oblique, internal oblique, and transversalis. They terminate in front in strong aponeuroses, arranged so as to form a sheath for a broad muscle, called the rectus, which extends perpendicularly on each side the linea alba from the sternum to the pubes.

EXTERNAL OBLIQUE. This muscle *arises* from the eight or nine lower ribs, by as many pointed bundles, called *digitations*. The upper five of these interdigitate with similar bundles of the serratus magnus; the three lower correspond in like manner with the origin of the latissimus dorsi; but they cannot be seen unless the body be turned on the side. The upper part of this muscle descends obliquely forwards, and terminates in the aponeurosis of the abdomen; the lower proceeds almost perpendicularly from the last ribs, and is *inserted* into the outer lip of more than the anterior half of the crest of the ilium.*

The *aponeurosis* of the external oblique increases in strength, breadth, and thickness, as it approaches the lower margin of the abdomen, this being the situation where the greater pressure of the viscera requires the most effective support. Its tendinous fibres take the same direction as the muscle, and form by their decussation in the middle line the *linea alba*, which extends from the ensiform cartilage to the pubes.

POUPART'S LIGAMENT OR CRURAL ARCH. Along the line of junction of the abdomen with the thigh, the aponeurosis extends from the anterior superior spine of the ilium to the spine of the pubes, and forms an arch over the intermediate bony excavation (p. 358). This, which is termed the *crural arch*, or more

* From its position and the direction of its fibres, it is manifest that the external oblique represents, in the abdomen, the external intercostal muscles of the chest.

commonly *Poupart's ligament*,* transmits the great vessels of the thigh, with muscles and nerves.

This ligament, when not separated from its fascial connections, does not run straight from the spine of the ilium to that of the pubes, but is slightly curved, with its convexity towards the thigh. Above, and somewhat to the outer side of the spine of the pubes, is situated an opening in the aponeurosis, called

FIG. 70.

1. External abdominal ring.
2. Gimbernat's ligament.
3. Poupart's ligament, or outer pillar of the ring.
4. Internal pillar of the ring.
5. Position of the internal ring, in dotted outline.

DIAGRAM OF POUPART'S LIGAMENT, OF THE APONEUROSIS OF THE EXTERNAL OBLIQUE, AND OF THE EXTERNAL ABDOMINAL RING.

the *external abdominal ring*. In the male it is a triangular opening about an inch long, with its base at the pubes, and will admit the passage of a finger; it transmits the spermatic cord. In the female it is smaller and transmits the round ligament of the uterus. It is bounded by the free margins of the aponeurosis

* This was first described by Fallopius, an Italian anatomist, in his 'Observationes Anatomicæ,' published in 1561. It was subsequently described by Poupart in 1705, in the 'Mém. de l'Acad. de Paris,' and is now commonly called 'Poupart's ligament.'

which are termed its columns or pillars. The *inner pillar* (No. 4 in the diagram) is thin, and is attached to the front of the pubes, decussating with its fellow of the opposite side in front of the symphysis. The *outer pillar* is thicker and stronger, and has three attachments; one, into the spine of the pubes—*Poupart's ligament* (No. 3); another, for nearly an inch along the linea ilio-pectinea—*Gimbernat's ligament* (No. 2); the third—or *triangular ligament*—consists of a few fibres which pass obliquely upwards and inwards beneath the inner pillar as far as the linea alba, where they are continuous with the aponeurosis of the opposite side. At the lower part of the aponeurosis of the external oblique, there are some arched fibres called *intercolumnar bands*, which are strongest above the external ring. Their use is to strengthen the opening and prevent the ring from enlarging.

Attached to the pillars of the external ring is a thin fascia, the *intercolumnar* or *spermatic fascia*, which is prolonged over the spermatic cord and testis, and thus forms one of the coverings of that organ.

The spermatic cord in its passage through the ring rests upon the external pillar.

DISSECTION. The external oblique should now be detached from the ribs and the crest of the ilium, and turned forwards as far as this can be done without injuring its aponeurosis or the crural arch. The second muscular stratum will thus be exposed and recognised by the difference in the direction of its fibres, which run upwards and inwards.

INTERNAL OBLIQUE. This muscle *arises* by fleshy fibres from the outer half of Poupart's ligament, from the anterior two-thirds of the middle lip of the crest of the ilium, and from the fascia lumborum.* The fibres ascend obliquely and are *inserted* as follows:—the posterior, into the cartilages of the three or four lower ribs; the middle, into the abdominal aponeurosis; and the anterior (which arise from Poupart's ligament) arch inwards over the spermatic cord, and descend somewhat to be in-

* The internal oblique represents, in the abdomen, the internal intercostal muscles of the thorax.

serted, in common with the tendon of the transversalis muscle into the pubes and for a short distance into the linea ilio-pectinea, immediately behind the external ring.

The aponeurosis of the internal oblique is the broad expanded tendinous tissue into which the muscle is anteriorly attached. It extends from the chest to the pelvis, and its fibres run in the same direction as the muscle. At the outer border of the rectus it splits into two layers: an anterior, which passes in front of the rectus in conjunction with the aponeurosis of the external oblique; and

FIG. 71.

1. Conjoined tendon of internal oblique and transversalis.

2. Cremaster muscle passing down in loops over the cord.

DIAGRAM OF THE LOWER FIBRES OF THE INTERNAL OBLIQUE AND TRANSVERSALIS, WITH THE CREMASTER MUSCLE.

a posterior, which, in common with the aponeurosis of the transversalis, passes behind the rectus. The two layers thus form a sheath for the rectus, which, except at the lower fourth behind, is complete. Midway between the umbilicus and the pubes, the aponeuroses of all the three muscles pass in front of the rectus, so that posteriorly in this situation it has no sheath. The lower free border of the posterior part of the sheath* marks the situation where the deep epigastric artery enters the substance of the rectus.

* Sometimes called the 'semilunar fold of Douglas.'

CREMASTER MUSCLE. The *cremaster* is a thin pale muscle, or the reverse, according to the condition of the subject. It is best to regard it as a detachment of the lowest fibres of the internal oblique, which, proceeding from Poupart's ligament, descend in front of the spermatic cord, and then arch up again to the spine and crest of the pubes, forming loops of different lengths; some reaching only as low as the external ring, others lower still, whilst the lowest spread out over the tunica vaginalis of the testis. The muscular fibres are frayed out, being connected by loose cellular tissue, and form a covering for the testis, called the *cremasteric fascia*. This muscle is absent in the female. Its nerve comes from the genital branch of the genito-crural, and its artery (*cremasteric*) from the deep epigastric.

DISSECTION. The internal oblique should now be detached from the ribs and the crest of the ilium, and turned forwards, without disturbing that portion of it connected with the crural arch. To avoid cutting away any part of the transversalis in reflecting the internal oblique, dissect near the crest of the ilium, and search for an artery which runs between these muscles and may be followed as a guide. This artery, called the *deep circumflexa ilii*, is a branch of the external iliac, and supplies the abdominal muscles. Beneath the internal oblique the continuations of the intercostal nerves and vessels are brought into view. These should be preserved.

TRANSVERSALIS ABDOMINIS. This muscle *arises* from the outer third of Poupart's ligament, from the anterior two-thirds of the crest of the ilium, from a strong fascia attached to the transverse processes of the lumbar vertebræ, and, lastly, from the inner surfaces of the six or seven lower costal cartilages, by digitations which correspond with those of the diaphragm. From this origin the fibres pass horizontally forwards and terminate anteriorly in a broad aponeurosis. Some of its fibres arch downwards, and are inserted with some fibres of the internal oblique by means of a conjoined tendon into the pubes.

The aponeurosis into which the fibres are inserted is broader below than above, and forms part of the posterior sheath of the rectus, excepting in the lower fourth, where it passes entirely in front.

Rectus Abdominis. This long muscle is situated vertically in front of the abdomen, and is enclosed in a sheath formed by the aponeuroses of the lateral muscles of the abdomen. To expose it, therefore, slit up the middle of the sheath, and reflect the two halves. It *arises* by two tendons, the *inner* and *smaller* of which is attached to the symphysis, the *outer* to the crest of the pubes. As the fibres pass up, the muscle becomes broader and thinner, and is inserted into the fifth, sixth, and seventh costal cartilages. Notice the tendinous intersections across the muscle called *lineæ transversæ*, which are incomplete repetitions of the ribs in the wall of the abdomen.* Their number varies from three to five, but there are always more above than below the umbilicus. These tendinous intersections adhere closely to the sheath in front, but not behind; consequently, pus formed between the front of the rectus and its sheath would be confined by two intersections; not so on the back of the muscle, where pus might travel down the entire length of it.

Fig. 72.

TRANSVERSE SECTION THROUGH THE ABDOMINAL MUSCLES TO SHOW THE FORMATION OF THE SHEATH OF THE RECTUS, THE QUADRATUS LUMBORUM AND THE ERECTOR SPINÆ.

The sheath of the rectus consists in front of the aponeurosis of the external oblique, and half the thickness of that of the internal oblique; while the back of the sheath comprises the aponeurosis of the transversalis, and half that of the internal oblique (fig. 71). This, however, applies only to the upper three-fourths of the muscle; the lower fourth has no sheath behind, since all the aponeuroses pass in front of it.

* Some animals—*e.g.* the crocodile—have bony abdominal ribs.

PYRAMIDALIS. This small triangular muscle is situated near the pubes, close to the linea alba, and has a sheath of its own. It *arises* from the upper part of the pubes in front of the rectus, and terminates in the linea alba about midway between the pubes and the umbilicus. It is often absent on one or even both sides.

Linea alba.—The aponeuroses of the abdominal muscles decussate along the middle line and form a white fibrous band, extending from the ensiform cartilage to the pubes. This is the *linea alba*: it is the fibrous continuation of the sternum and is broader above than below. A little lower than the middle is the umbilicus.

The linea alba, being the thinnest part of the abdomen, and free from large blood-vessels, is chosen as a safe line for tapping in dropsy, for puncturing the bladder in retention of urine, and for ovariotomy.

Lineæ semilunares.—These are the two slightly curved lines, on the front of the abdomen, corresponding with the outer margins of the two recti muscles. They are formed by the junction of the aponeuroses of the lateral muscles.

The abdominal muscles serve many important purposes:—

FUNCTIONS OF THE ABDOMINAL MUSCLES. 1st. *In tranquil expiration* they push the diaphragm upwards by gentle pressure on the abdominal viscera.

In forcible expiration the same process takes place, but with greater energy. This is variously exemplified in coughing, sneezing, and laughing.

2nd. *In vomiting*, the diaphragm being fixed* by the closure of the glottis, the abdominal muscles contract, and assist the stomach to expel its contents.

3rd. In conjunction with the contracted diaphragm, they assist the muscular walls of the bladder and rectum in the expulsion of urine and fæces, and the action of the uterus in parturition. They exercise a gentle pressure and support on the abdominal viscera, and shield them from injury by strongly contracting when a blow is anticipated.

* By the term 'fixed,' it is meant that the diaphragm forms a resisting surface.

4th. They are movers of the trunk in various ways. For example, the right external oblique acting with the left internal oblique will rotate the chest towards the left side, as in mowing, and *vice versâ*.

The rectus is chiefly concerned in raising the body from the horizontal position, as anyone may ascertain by placing his hand on the abdomen while rising from the ground.

DISSECTION. By dividing the rectus transversely near the umbilicus, and raising it from its position, we have a complete view of the manner in which the sheath is formed; we observe, too, that this is absent behind the lower fourth of the muscle. Ramifying in the substance of the muscle is a large artery, called the *deep epigastric*, a branch of the external iliac; also the continuation of the internal mammary, which descends from the subclavian.

NERVES OF THE ABDOMINAL WALL. These nerves are the continuations of the six lower intercostal nerves, and of the first lumbar. They have the same general course and distribution. They run forwards under the costal cartilages between the internal oblique and transversalis towards the rectus. They furnish branches to the abdominal muscles, and each gives off its lateral and anterior cutaneous branches, described p. 150.

DISSECTION. The transversalis muscle must now be reflected with the rectus by incisions similar to those for the reflection of the aponeurosis of the external oblique. The parts must be disturbed as little as possible, so that the bearing of the transversalis fascia in reference to the anatomy of the parts concerned in hernia may be thoroughly examined.

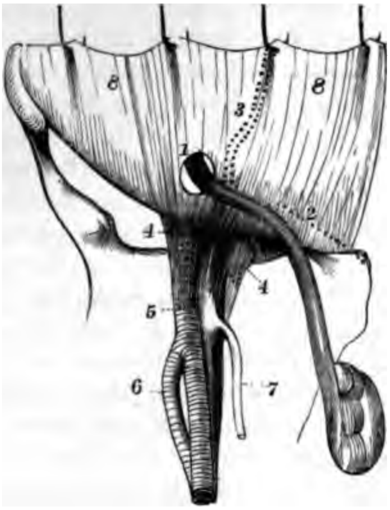
DISSECTION OF THE PARTS CONCERNED IN INGUINAL HERNIA.

FASCIA TRANSVERSALIS. This fascia is so called because it lies in contact with the posterior surface of the transversalis muscle. It is comparatively thin, superiorly, where it is continuous with the fascia on the under surface of the diaphragm.

Inferiorly, it is attached to the crest of the ilium and to Poupart's ligament, where it becomes continuous with the fascia covering the iliacus internus (fascia iliaca). About the middle of Poupart's ligament it sends a funnel-shaped prolongation downwards into the thigh, forming the anterior part of the sheath of the femoral vessels. Its inner border is connected with the margin of the rectus, to the lower margin of the conjoined tendon, and also to the pubes. This fascia is strongest just behind the external

FIG. 73.

1. Internal abdominal ring.
2. Position of the external abdominal ring in dotted outline.
3. Epigastric a. in dotted outline.



4, 4. Sheath of the femoral vessels, continued from the fascia transversalis.
5. Femoral a.
6. Profunda a.
7. Saphena v.
8, 8. Fascia transversalis.

DIAGRAM OF THE FASCIA TRANSVERSALIS SEEN FROM THE FRONT.

abdominal ring, and, but for it and the conjoined tendon, there would be a direct opening into the abdominal cavity through the external ring. The outer half of the fascia is very firmly connected to Poupart's ligament and to the fascia iliaca; but the inner half is loosely connected with the crural arch, and passes down under it, as before stated, over the femoral vessels into the thigh, and forms the front of what is termed the femoral sheath.

INTERNAL ABDOMINAL RING. The opening in the fascia transversalis through which the spermatic cord passes is called the

internal abdominal ring (or the inner aperture of the inguinal canal). It corresponds to a point midway between the anterior superior spine of the ilium and the spine of the pubes, and about two-thirds of an inch above the crural arch. It is oval with the long diameter nearly vertical; its margin is well defined on the inner, but not on the outer side, and from its border is continued forwards a funnel-shaped prolongation over the spermatic cord, which passes through the ring. This covering, thin and delicate, is termed the *infundibuliform fascia*. (This is not seen in the diagram.) Close by the inner border of the internal ring, the deep epigastric artery ascends to enter the substance of the rectus.

DISSECTION. To see that part of the peritoneum concerned in inguinal hernia, the fascia transversalis must be removed by incisions similar to those recommended before. The fascia is easily separable from the peritoneum which is situated immediately behind it. The peritoneum at the inner ring presents a well-marked depression, which varies, however, considerably: in some being scarcely visible; in others, being continued downwards into the inguinal canal, in the form of a pouch. In some instances, a communication is found between the general cavity of the peritoneum and the tunica vaginalis testis.

INGUINAL CANAL. Having examined the several strata through which the spermatic cord passes, replace them in their natural position, and examine the inguinal canal as a whole. Its direction is obliquely downwards and inwards. Its length in a well-formed adult male is from one and a half to two inches. It is bounded *in front* by the aponeurosis of the external oblique, and externally by a small portion of the internal oblique; *behind*, by the fascia transversalis and the conjoined tendon of the internal oblique and transversalis; *above*, by the lower fleshy fibres of the internal oblique and transversalis; *below*, by the crural arch.

COURSE AND RELATIONS OF THE DEEP EPIGASTRIC ARTERY. From a surgical point of view this is one of the most important arteries in the body. It arises from the external iliac, just before this vessel passes under the crural arch. It ascends inwards

between the fascia transversalis and the peritoneum, forms a gentle curve on the inner side of the internal abdominal ring, and consequently on the inner side of the spermatic cord, and then enters the rectus muscle below the edge of the sheath.

The artery runs in the substance of the rectus parallel with the linea alba, and is accompanied by two veins, of which the larger is on its inner side. They terminate by a single trunk in the iliac vein.

BRANCHES OF THE DEEP EPIGASTRIC.

The *pubic* is the most important branch. It runs inwards, behind the crural arch, towards the pubes, behind which it anastomoses with the pubic branch of the obturator. Sometimes the obturator artery is absent, in which case the pubic branch of the epigastric enlarges and takes the place of the absent vessel. It derives its chief practical interest from the fact that it is liable to be wounded in dividing the stricture in femoral hernia.* But its size varies in different subjects, and is sometimes so small as to escape observation. The second branch is the *cremasteric.* It supplies the coverings of the cord, but chiefly the cremaster muscle. After giving off other unnamed *muscular branches* the main trunk terminates in the rectus by inosculations with the internal mammary.

DEEP CIRCUMFLEXA ILII.

The deep circumflexa ilii artery is a branch of the external iliac, just above the crural arch; it runs upwards and outwards parallel with Poupart's ligament, and at the middle of the crest of the ilium pierces the transversalis muscle, and, running in the same direction, lies between the transversalis and internal oblique. It anastomoses with the iliolumbar artery, and sends small muscular branches, which run upwards, and communicate with the epigastric and the lumbar arteries.

The circumflex iliac *vein* crosses the external iliac artery and opens into the external iliac vein.

Such is an outline of the anatomy of the parts concerned in

* There is a preparation (No. 83, Ser. 17) in the Museum of St. Bartholomew's Hospital quite to the point. The patient had profuse hæmorrhage, which commenced five hours after the operation. He died from peritonitis.

inguinal hernia. The description applies equally to the female, provided the round ligament be substituted for the spermatic cord. The inguinal canal is proportionately smaller, and there is no cremaster.

PRACTICAL APPLICATION. The testis originally formed in the loins passes, about the eighth month of fœtal life, from the abdomen into the scrotum, through an oblique canal in the wall of the abdomen, called the inguinal canal. A portion of peritoneum is pouched out before the descending testis, and constitutes the tunica vaginalis testis. The blood-vessels, nerves, and vas deferens pass down with the testis, and constitute the spermatic cord. The inguinal canal runs obliquely through the abdominal wall, that it may the better resist the protrusion of intestine.

The wall of the abdomen, as previously stated, is composed of various strata, and the testis and cord in their passage through each stratum derive from each a covering similar in structure to the stratum itself. Of these strata there are three: the first, proceeding from within outwards, is the *fascial stratum* derived from the fascia transversalis; the second is the *muscular stratum* (cremasteric) from the internal oblique and transversalis muscles; the third is the *aponeurotic stratum* from the external oblique.

The passage of the testis through the lower part of the abdominal parietes (inguinal canal) occasions, at this part of the belly, a natural weakness which, associated with other conditions, favours the protrusion of intestine in this situation.

A protrusion of intestine through any part of the inguinal canal is called an inguinal hernia.

OBLIQUE INGUINAL HERNIA. The most common form of inguinal hernia is that in which a portion of intestine protrudes first through the internal ring, then, traversing the inguinal canal, emerges through the external ring, and thence may descend into the scrotum. This variety is called an *oblique inguinal hernia.** If the intestine stops within the inguinal canal, it

* A hernia is sometimes called *external* or *internal*, according to the relation of the protrusion to the deep epigastric artery: thus, an oblique inguinal hernia which first protrudes through the inner ring is called an *external hernia*, and *vice versâ*.

is called an *incomplete inguinal hernia*; if, however, the protrusion has emerged through the external ring, it is called a *complete inguinal hernia*; and, lastly, if it descends into the scrotum, it is called a *scrotal hernia*.

DIRECT INGUINAL HERNIA. The intestine, however, does not always escape through the internal ring. Sometimes it protrudes *internal* to the deep epigastric artery through a triangular weak place, bounded on the inner side by the rectus, on the outer side by the deep epigastric artery, and below by Poupart's ligament. This space* is relatively weak, having in front of it only the fascia transversalis and the conjoined tendon of the internal oblique and transversalis; moreover, it is situated immediately behind the external abdominal ring. A portion of intestine protruding through this triangle comes directly forwards through the external ring, and the hernia is then called a *direct inguinal hernia*.

COVERINGS OF AN OBLIQUE INGUINAL HERNIA. A *complete* oblique inguinal hernia, passing as it does through the same structures as the testis did in fœtal life, receives the same coverings as that gland; they are:—

1. The *skin* and the *superficial fascia*.
2. The *intercolumnar fascia*, derived from the external oblique.
3. The *cremaster* derived from the internal oblique and transversalis.†
4. The *infundibuliform fascia*, derived from the fascia transversalis.
5. The *subperitoneal fat*, and the *peritoneum* which constitutes the sac.

An *incomplete* oblique inguinal hernia is covered by—

1. The *skin* and *superficial fascia*.
2. The *aponeurosis* of the *external oblique*.
3. The *cremaster*.
4. The *infundibuliform fascia*.
5. The *subperitoneal fat* and the *peritoneum*.

COVERINGS OF A DIRECT INGUINAL HERNIA. A *direct* inguinal hernia protrudes immediately on the inner side of the epigastric artery through the external ring; and its course forwards is mainly

* Sometimes called Hesselbach's triangle.

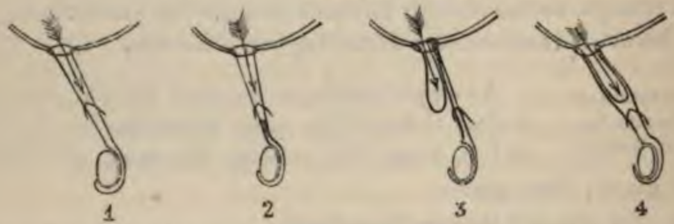
† The cremaster muscle is absent in the female.

prevented by the resistance of the conjoined tendon.* This hernia is covered by—

1. The *skin* and *superficial fascia.*
2. The *intercolumnar fascia.*
3. The *conjoined tendon* of the internal oblique and transversalis.
4. The *fascia transversalis.*
5. The *subperitoneal fat* and the *peritoneum.*

In almost all cases, the immediate investment of the intestine is the parietal layer of the peritoneum. This constitutes the *sac* of the hernia. The opening of the sac, communicating with the abdomen, is called its *mouth*; then comes the narrow, con-

FIG. 74.



VARIETIES OF CONGENITAL INGUINAL HERNIÆ, CONSEQUENT UPON SOME DEFECT IN THE DEVELOPMENT OF THE SPERMATIC PORTION OF THE TUNICA VAGINALIS. THE ARROWS MARK THE PROTRUSION.

1. Hernia in the tunica vaginalis testis.
2. Hernia in the funicular portion of the tunica vaginalis.
3. Infantile hernia.
4. Encysted hernia.

stricted portion, or *neck*; and lastly, the *body*, or expanded part of the sac.

CONGENITAL HERNIÆ. Owing to the comparatively late descent of the testis in fœtal life, it frequently happens that either no closure, or only a partial closure, takes place in the vaginal portion of the tunica vaginalis. Under these conditions, when a protrusion takes place, the intestine does not push forwards a sac derived from the parietal layer of the peritoneum, but it lies in a

* In our experience the weakness of the conjoined tendon is, anatomically speaking, the determining cause of this form of hernia.

sac formed by the tunica vaginalis, which still communicates with the peritoneal cavity. These herniæ are always oblique, and are termed *congenital*.* There are four varieties, all of which are the result of, or associated with, some congenital defect. They are as follows :—

1. *Hernia* in the *tunica vaginalis testis*.—This occurs when a protrusion of intestine takes place through the narrow canal which persists between the general cavity of the peritoneum and the tunica vaginalis testis, in consequence of the non-obliteration of the original communication between them. In this case, the intestine surrounds the testis, and the sac is formed by the tunica vaginalis testis (fig. 74. 1.).

2. Hernia in the *funicular portion* of the *tunica vaginalis* occurs when an incomplete closure of the tunica vaginalis takes place immediately above the testis; the canal above it being still unclosed and communicating with the peritoneal cavity. The sac is formed by the original pouch of the peritoneum in the descent of the testis, although shut off from the tunica vaginalis testis by a thin septum (fig. 2).

3. *Infantile hernia* is rare, and occurs when the original peritoneal canal is occluded at the inner ring, so that the tunica vaginalis testis reaches up as high as the canal, or even as far as the internal ring. The intestine in this variety protrudes a sac through the inner ring, but behind this abnormal extension of the tunica vaginalis; so that in front of the hernia there are three layers of peritoneum : two formed by the tunica vaginalis, the third by the sac (fig. 3).

4. *Encysted hernia* is still rarer than the preceding, and may occur in those cases in which the closing septum at the internal ring is so thin that an advancing hernia pushes before it this thin stratum (which forms its sac) as a diverticulum into an unclosed tunica vaginalis (fig. 4).

POSITION OF SPERMATIC CORD. The spermatic cord is generally situated behind and to the outer side of a hernial sac. In some cases, however, the hernia separates the constituents of the cord, so that one or other of these comes to lie in front of the protrusion.

SEAT OF STRICTURE. The stricture may be seated either at the external ring, the internal ring, at any intermediate

* The term *congenital* applied to this form of hernia is apt to suggest the idea that it occurs at birth. But this is not of necessity so. Although the state of parts favourable to its occurrence exists at birth, the hernia itself may not take place till many years afterwards—in fact, at any period of life.

part between these, or at the neck of the sac. Sometimes there is a double stricture, one at the external ring, the other at the internal.

As stated, the stricture may be caused by the neck of the sac, independently of the parts outside it; for the peritoneum may become thickened and indurated, and sufficiently unyielding to strangulate the protruded intestine. The strangulation in a congenital hernia is nearly always caused by the neck of the sac itself.

In dividing the stricture, the surgeon should, in all cases, adhere to the golden rule laid down by Sir Astley Cooper—namely, to divide it directly upwards. In this direction, there is the least likelihood of wounding the deep epigastric artery.

CHANGES PRODUCED BY AN OLD AND LARGE HERNIA.

Whoever has the opportunity of dissecting an old hernia, of some size, will observe that the obliquity of the inguinal canal is destroyed. The constant dragging of the protruded viscera upon the inner margin of the internal ring gradually approximates the internal ring to the external, so that at last the one gets quite behind the other, and there is a direct opening into the abdomen. But the position of the deep epigastric artery with regard to the sac remains unaltered. It is still on the *inner side* of the neck of the sac.

In herniæ of long standing, all its coverings undergo a change. They become thickened and hypertrophied, and so altered from what they once were that they scarcely look like the same parts.

DISSECTION.

Expose the contents of the abdomen, by an incision from the ensiform cartilage to the pubes a little to the left side of the linea alba, so as to preserve a ligament, *ligamentum teres*, which passes from the umbilicus to the liver, and also a cord, the *urachus*, which ascends in the middle line from the bladder to the umbilicus; then make another incision transversely on a level with the umbilicus, and turn the flaps outwards.

URACHUS.

Behind the linea alba, the peritoneum is raised into a fold by a fibrous cord, passing from the

bladder to the umbilicus; this is the *urachus*, which in fœtal life is a tube connecting the bladder with the allantois. On either side of the urachus are two other folds inclosing cords which ascend obliquely towards the umbilicus: these are the impervious remains of the hypogastric arteries.

Take now a survey of the viscera before they are disturbed from their relative positions.

WHAT IS SEEN ON OPENING THE ABDOMEN.

In the right hypochondrium the liver is seen projecting more or less below the cartilages of the ribs, and the fundus of the gall-bladder below the edge of the liver, near the end of the ninth costal cartilage. In the left hypochondrium is seen more or less of the stomach according to its distension. Across the umbilical region extends a broad fold of the peritoneum containing fat, the great omentum, which descends from the lower curvature of the stomach, forming a curtain over the convolutions of the small intestine. The breadth of this fold varies; sometimes being so shrunk and crumpled as to be scarcely visible. The lower part of the abdomen and part of the pelvis are occupied by the small intestine. The urinary bladder is not apparent, unless distended sufficiently to rise out of the pelvis. In the right iliac fossa is the caput coli, the commencement of the large intestine; but the ascending part of the large intestine in the right lumbar region, and the descending part of it in the left, are not visible unless distended: they lie contracted at the back of the abdomen. Such are the viscera usually seen on opening the abdomen; but a certain latitude is to be allowed, as sometimes more of one organ is seen and less of another, according as this or that is distended or hypertrophied. Much also depends upon the amount of pressure which the ribs have undergone during life.

PARTICULAR POSITION OF EACH VISCUS.

The position of each viscus should now be examined separately, and first that of the stomach.

THE STOMACH.

The stomach is irregularly conical in shape. Its great end is situated in the left hypochondrium; its narrow or pyloric end extends obliquely across the epigastrium into the right hypochondrium, where it is overlapped by the liver.

The relative position and size of the stomach vary according to the amount of distension; when much distended, the anterior surface, owing to the greater mobility of the great curve and the pyloric end of the stomach, is turned upwards, and the lower border, forwards. The following peritoneal folds are attached to the stomach: 1. the great omentum already described; 2. the gastro-hepatic or lesser omentum, which connects the lesser curve of the stomach with the transverse fissure of the liver; and 3. the gastro-splenic omentum, which connects the great end of the stomach with the spleen.

DUODENUM. The first part of the intestinal canal is termed *intestinum duodenum*, because it is about the breadth of twelve fingers. Commencing at the pyloric end of the stomach, the duodenum ascends as high as the neck of the gall-bladder; then turning downwards it passes in front of the right kidney; lastly, making another bend, it crosses the spine obliquely towards the left side of the second lumbar vertebra. Here the intestinum jejunum begins, and this part of the canal may be seen by raising the transverse colon. Thus the duodenum describes a kind of horse-shoe curve, of which the concavity is towards the left, and embraces the large end or head of the pancreas. For convenience of description the duodenum is divided into an ascending, a descending, and a transverse portion. The first is completely surrounded by a peritoneal covering; the second and third are only covered by peritoneum in front, and are fixed to the back of the abdomen. The relative anatomy of the duodenum will be more fully seen hereafter.

JEJUNUM AND ILEUM. Pursuing its course from the left side of the second lumbar vertebra, the intestinal canal forms a number of convolutions, which are loosely connected to the spine by a broad peritoneal fold termed the *mesentery*. Of these convolutions, the upper two-fifths constitute the *intestinum jejunum*; the lower three-fifths, the *intestinum ileum*. This is an arbitrary division. There is no definite limit: the character of the bowel gradually changes—that is, it becomes less vascular, has fewer folds of the lining membrane, and its coats are therefore less substantial to the feel.

Commencement of Large Intestine. In the right iliac fossa, the small intestine opens into the left side of the colon, which is easily recognised by its sacculated appearance: here the large intestine begins: here is the ilio-cæcal valve (fig. 75). Immediately below the junction, the large intestine is expanded into a blind pouch, called the *cæcum* or *caput coli.* Into the back part of this pouch opens a little tube closed at the other end, called the *appendix vermiformis.* This tube is generally three inches long, about as thick as a large earthworm, and

Fig. 75.

1. Ileum.
2. Cæcum or caput coli.
3. Appendix vermiformis.

SECTION THROUGH THE JUNCTION OF THE LARGE AND SMALL INTESTINE TO SHOW THE ILIO-CÆCAL VALVE AND APPENDIX VERMIFORMIS.

is either coiled up behind the cæcum, or connected to it by a peritoneal fold, so as to hang loose in the pelvis. The commencement of the large intestine is generally confined by the peritoneum to the iliac fossa, in which it lies.* Tracing it from this point, it ascends through the right lumbar region in front of the right kidney as high as the under surface of the liver, where it

* But this is not invariably so. The bowel is, in some subjects, connected to the fossa by a fold of peritoneum or a *meso-cæcum.* I have seen this fold sufficiently loose to allow the caput coli to travel over to the left iliac fossa.

makes a bend—the *hepatic flexure*—and crosses the umbilical region towards the left side. Having reached the lower border of the spleen, it makes another bend downwards, forming the *splenic flexure* of the colon;* thence it descends in front of the left kidney† through the left lumbar region into the left iliac fossa, where it curves like the letter S. These successive portions of the large intestine are termed, respectively, the ascending, transverse, descending, and sigmoid parts of its course. Lastly, the bowel enters the pelvis on the left side of the sacrum, and here takes the name of *rectum*. This term, so far as concerns the human subject, is misapplied; the canal runs anything but a straight course through the pelvis, since it curves to adapt itself to the sacrum.

Fig. 76.

RELATIVE POSITION OF THE KIDNEYS AND THE LARGE INTESTINE SEEN FROM BEHIND.

L. K. Left kidney, crossed obliquely by the last dorsal artery and nerve.
R. K. Right kidney.
A. C. Ascending colon
D. C. Descending colon.

Looking at the entire course of the colon, observe that it forms an arch, of which the concavity embraces the convolutions of the small intestines.

* This transverse part of the colon, in some instances, makes a coil behind the stomach to the diaphragm; such a state of things, when the bowel happens to be distended, is apt to give rise to symptoms of diseased heart. See some observations in point by Dr. Copland, in 'Lond. Med. Gaz.' 1847, vol. v. p. 660.

† The contiguity of the ascending and descending colon to the right and left kidney respectively, explains the occasional bursting of renal abscesses into the intestinal canal.

LENGTH OF THE ALIMENTARY CANAL. The small intestine, including the duodenum, varies from sixteen to twenty-four feet in length, and the large intestine from five feet to five feet and a half; these measurements are subject to some variation according to the height of the individual. In round numbers, the small and large intestines are from five to six times the length of the body.

SITUATION OF THE LIVER. The *liver* occupies the whole of the right hypochondrium, and extends over the epigastric region more or less into the left. Unless the individual be very corpulent, we can ascertain during life the extent to which the liver projects below the costal cartilages, and the general dimensions of the organ may be tolerably well told by percussion. Its anterior border is sharp and thin; its posterior is broad and connected to the diaphragm by peritoneal ligaments. Its upper surface ascends as high as the fifth intercostal space; its under surface overlies part of the stomach, of the duodenum, of the right kidney, of the transverse colon, and of the supra-renal capsule; its upper surface is convex, and accurately adapted to the arch of the diaphragm. To this muscle the liver is connected by folds of peritoneum, called ligaments. One of these, nearly longitudinal in direction, and called the *suspensory*, or, from its shape, the *falciform* ligament, is situated a little to the right of the mesial line. The lower and free edge of it contains the impervious remains of the umbilical vein, called the *round* ligament. The suspensory ligament, traced backwards, leads to another broad fold extending horizontally from the diaphragm to the posterior border of the liver; this constitutes the *lateral* ligament, right or left, according as we trace it on one or the other side of the falciform ligament.

The junction of the lateral and falciform ligaments is described by some authors as the *coronary* ligament.

SITUATION OF THE GALL-BLADDER. The gall-bladder is the reservoir for the bile, and is closely confined by the peritoneum in a slight depression on the under surface of the right lobe of the liver. Its lower end or fundus projects beneath the cartilage of the ninth rib. This is important practically. It sometimes happens that

the gall-bladder, in consequence of some obstruction to its duct, becomes unusually distended, and occasions a swelling below the margin of the ribs, which might be mistaken for an hepatic abscess.* The close proximity of the gall-bladder to the duodenum and the transverse colon explains the occasional evacuation of gall-stones by ulceration into the intestinal canal.†

SITUATION OF THE SPLEEN. The spleen is deeply situated in the left hypochondrium, between the stomach and the ninth, tenth, and eleventh ribs. It is placed nearly vertically; its outer surface is smooth and convex, to correspond with the diaphragm and the ribs; its inner surface, where its great vessels enter, is concave and connected to the great end of the stomach by a peritoneal fold called the *gastro-splenic omentum*. Generally, too, the spleen is connected by a small peritoneal fold, the *suspensory ligament*, to the under surface of the diaphragm.‡ Below, the spleen is in contact with the kidney and the descending colon.

SITUATION OF THE PANCREAS. This is the salivary gland of the abdomen. It lies behind the stomach, transversely across the spine, about the level of the first lumbar vertebra. Its right end or head is contained within the curve of the duodenum; its left end or tail extends as far as the spleen. The further connections and relations of the pancreas cannot at this stage of the dissection be satisfactorily seen.

SITUATION OF THE KIDNEYS. The kidneys are situated in the lumbar region, nearly opposite the two lower dorsal and the two upper lumbar vertebræ; the right, owing to the size of the liver, being a little lower than the left. They lie embedded in fat, partly upon the quadratus lumborum, partly upon the psoas. In contact with the right kidney, we have the liver, the second part of the duodenum, and the ascending colon; in contact with the left, are the spleen, the end of the pancreas, and the descending colon.

* See cases in point recorded by Andral, 'Clin. Méd.' tom. iv.; and Graves, 'Dublin Hospital Report,' vol. iv.

† See preparations in the Museum, Ser. 16. No. 84.

‡ Every now and then we find in the gastro-splenic omentum one or more little spleens in addition to the large one.

SITUATION OF THE SUPRA-RENAL CAPSULE. This body is situated at the top of the kidney. It lies upon the crus of the diaphragm. You will see the right supra-renal capsule by lifting up the liver; the left, by lifting up the spleen and the great end of the stomach.

PERITONEUM. A certain range of motion being necessary to the abdominal viscera, they are provided with a serous membrane, called the *peritoneum*. This membrane, like other serous membranes, is a closed sac, one part of which lines the containing cavity, the other is reflected over the contained viscera. These are respectively termed the *parietal* and the *visceral* layers. In the female, however, it is not, strictly speaking, a closed sac, since it communicates with the cavity of the uterus through the Fallopian tubes. The internal surface of the peritoneum is smooth and polished, and lined by squamous endothelium: the external surface, the *sub-peritoneal tissue*, is composed of areolar tissue which connects the internal layer to the invested viscus or abdominal parietes. There is nothing between the parietal and the visceral layers—in other words, inside the sac—but just sufficient moisture to lubricate its smooth and polished surface. The viscera are all, more or less, outside the sac; some lie altogether behind it, as the pancreas, kidneys, and supra-renal capsules; others, as the lower parts of the duodenum, cæcum, ascending and descending colon, are only partially covered by it; while others, as the stomach, liver, jejunum, ileum, and some parts of the large intestine, are completely invested by it: these latter push the visceral layer before them, and so give rise to membranous folds; the larger the fold, the freer is the mobility of the viscus which occasions it.

COURSE OF THE PERITONEUM. Now trace the peritoneum as a continuous membrane. Since the peritoneum is a perfect sac, it matters not where we begin: we must come back to the starting-point.

If a longitudinal section be made through the viscera in the middle of the body, one can trace the peritoneum thus—beginning at the diaphragm, and taking, for brevity's sake, two layers at a time (fig. 77).

From the diaphragm two layers of peritoneum proceed to the liver, forming its lateral ligaments; they separate to inclose the liver, meet again on its under aspect, and pass on, under the name of the gastro-hepatic omentum, to the small curve of the stomach. Separating here, they embrace the stomach, and, meeting again at its greater curve, pass down like a curtain over the small intestine to form the great omentum. At the lower margin of the great omentum, they are reflected upwards (so that the great omentum consists of four layers) to the front of the transverse colon, which they inclose, and, after joining again at the back of the colon, proceed to the spine, forming the transverse meso-colon. At this situation the two layers diverge, the upper one ascends in front of the pancreas, and the crura of the diaphragm to its under surface, at which point we started.*

Fig. 77.

DIAGRAM OF THE PERITONEUM.

The lower layer is reflected from the spine over the small intestine, back again to the spine, to form the mesentery. From the root of the mesentery it descends into the pelvis, and invests the upper two-thirds of the rectum. From the rectum, in the male, it is reflected to the posterior part of the

* In fœtal life, the ascending layers of the great omentum may be traced back to the spine near the pancreas; and here the layers diverge from each other. The upper layer ascends in front of the pancreas to the diaphragm; the lower layer proceeds over the arch of the colon, and then back to the spine, thus forming the transverse meso-colon. Its reflections afterwards are the same as in the adult. As the fœtus grows, the great omentum becomes adherent to the arch of the colon.

bladder, forming the recto-vesical pouch, and thence to the wall of the abdomen, along which it can be traced up to the diaphragm. In the female, it is reflected from the rectum on to the posterior wall of the vagina half an inch from the uterine extremity, constituting the recto-vaginal pouch, and thence over all the back, but only about half-way down the front of the uterus, to the posterior wall of the bladder; after which its reflections are the same as in the male.

Such is the course of the peritoneum as seen in a longitudinal section, but there are lateral reflections which cannot be seen except in a transverse section: thus, from the great end of the stomach, two layers proceed to the spleen, forming the gastro-splenic omentum; from the transverse meso-colon it is reflected on either side over the ascending and descending colon.

The following parts of the alimentary canal are only partially covered by peritoneum: namely, the descending and transverse portions of the duodenum, the cæcum, the ascending and descending colon (with exceptional cases), and the lower part of the rectum.

Anatomists speak of the *lesser* cavity of the peritoneum as distinguished from the greater. This lesser cavity, or sac of the omentum, is situated behind the stomach and the descending layers of the great omentum. If air be blown through the foramen of Winslow (which is the constricted communication between the greater and lesser cavities of the peritoneum), the lesser cavity becomes distended; it is bounded, in front, by the lesser omentum, the stomach, and the descending layers of the great omentum; behind, by the ascending layers of the great omentum, the colon, and the transverse meso-colon; above, by the liver.

FORAMEN OF WINSLOW. This foramen is the narrow circular opening between the greater and lesser cavities of the peritoneum, through which the two cavities communicate. It is situated behind the right edge of the gastro-hepatic, or lesser omentum. By passing your finger into it, you will find the foramen bounded *above* by the lobulus Spigelii of the liver; *below*, by the commencement of the duodenum; *in front*, by the lesser omentum; and *behind*, by the vena cava inferior.

The several folds, formed by the reflections of the peritoneum, which connect the viscera either to each other or to the back of the abdomen, have now to be examined.

Fig. 78.

G.P. Greater cavity of the peritoneum.
L.P. Lesser cavity of the peritoneum.
A. Aorta.

St. Stomach.
S. Spleen.
V. Inferior vena cava.
L. Liver.

DIAGRAM OF A TRANSVERSE SECTION THROUGH THE UPPER PART OF THE ABDOMINAL CAVITY SEEN FROM ABOVE.

MESENTERY. This is the fold which suspends the small intestine from the back of the abdomen. To see it, raise the great omentum and the transverse arch of the colon. Its

Fig. 79.

G.O. The great omentum, with its cavity.
I. Small intestine.
A. Aorta.

V. Inferior vena cava.
A.C. Ascending colon.
D.C. Descending colon.
K. Kidneys.

DIAGRAM OF A TRANSVERSE SECTION THROUGH THE LOWER PART OF THE ABDOMINAL CAVITY.

attached part or root extends from the left side of the second lumbar vertebra obliquely across the spine to the right iliac fossa. The loose part of the mesentery is very broad, and curves like

a ruffle, inclosing the small intestine from the beginning of the jejunum to the end of the ileum. We must trace between its two layers, the mesenteric vessels, nerves, glands, and lymphatics.

Transverse Meso-colon. This broad fold connects the transverse colon to the back of the abdomen. It forms an imperfect partition dividing the abdomen into an upper compartment, containing the stomach, liver, and spleen; and a lower, containing the convolutions of the small intestines. As regards the cæcum, the ascending and descending portions of the colon, they are, as a general rule, bound down by the peritoneum in their respective situations (fig. 79). The peritoneum covers only two-thirds or thereabouts of their anterior surface; their posterior surface is connected by loose cellular tissue to the back of the abdomen.* The colon, ascending or descending, can therefore be opened in the lumbar region, below the kidney, without injury to the peritoneum: a fact upon which is founded the operation of colotomy for the relief of stricture of the rectum.

Great Omentum. This broad peritoneal fold is composed of four layers, and proceeds from the lower border of the stomach, like a curtain over the convolutions of the small intestine. Its thickness varies considerably; in thin subjects it is often translucent; in corpulent persons, on the other hand, it is loaded with fat, and contributes in great measure to the size of the abdomen. Its length also varies. In some bodies we find it extending low into the pelvis; in others, small and crumpled.

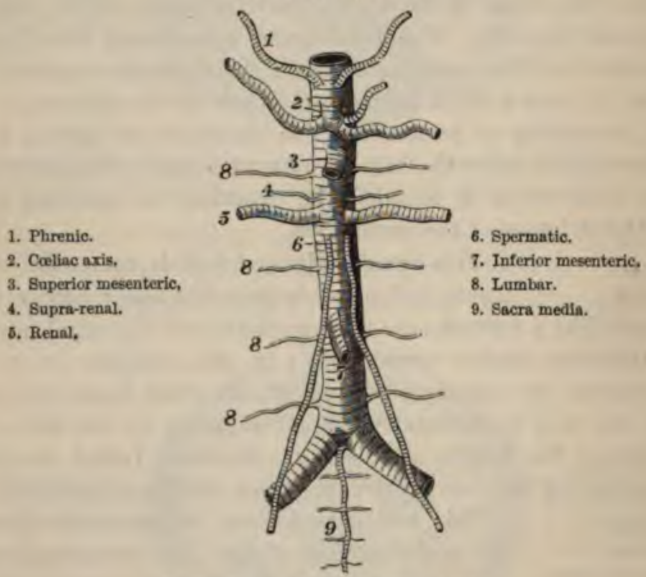
Gastro-hepatic or Lesser Omentum. This fold passes from the transverse fissure on the under surface of the liver to the upper curve of the stomach. It is composed of two layers, and between them are the portal vein and hepatic artery with the nerves going to the liver, and the hepatic duct and lymphatics coming from it. The right border of this fold is free, while the left passes on to the œsophagus. In this fold the bile-duct lies to the right, the hepatic artery to the left, and the vena portæ behind and between

* In some (rare) cases, the ascending and descending colon (more commonly the latter) are *completely* surrounded by peritoneum, and connected to the lumbar regions, respectively, by a right and left lumbar meso-colon.

them. If the finger be introduced behind the right border, it passes through the foramen of Winslow into the lesser cavity of the peritoneum.

GASTRO-SPLENIC OMENTUM. This fold proceeds from the great end of the stomach to the spleen, and is continuous below with the great omentum. It contains between its layers the branches, *vasa brevia*, which proceed from the splenic artery to the great end of the stomach.

FIG. 80.



BRANCHES OF THE ABDOMINAL AORTA.

The reflections of the peritoneum from the liver to the abdominal walls, forming its ligaments, have been described in tracing the connections of that organ (p. 377).

BRANCHES OF THE ABDOMINAL AORTA. Our next object should be the examination of the arteries which supply the viscera. The aorta enters the abdomen between the pillars of the diaphragm in front of the last dorsal vertebra, and then, descending

a little to the left side of the spine, divides on the fourth lumbar vertebra into the two common iliac arteries. In this course it gives off its branches in the following order (fig. 80):—

1. The *phrenic*, for the supply of the diaphragm.

2. The *cœliac axis*, a short thick trunk which immediately subdivides into three branches for the supply of the stomach, the liver, and the spleen.

3. The *superior mesenteric*, for the supply of all the small intestine and the upper half of the large.

4, 5. The *supra-renal* and the *renal* arteries.

6. The *spermatic*, for the testicles; the *ovarian*, for the ovaries.

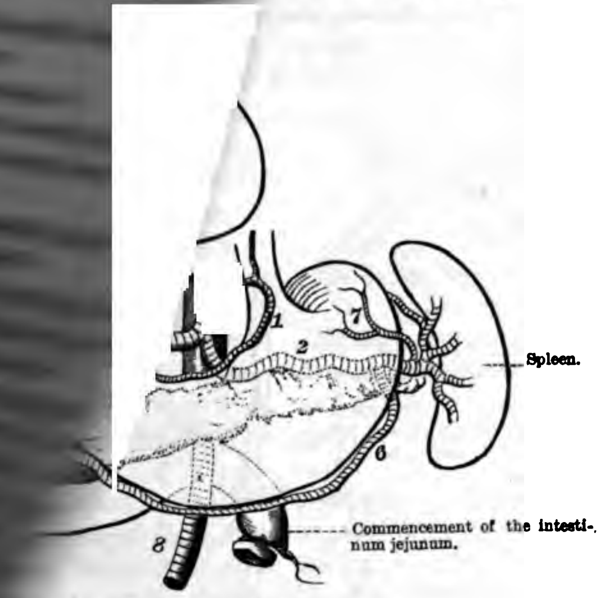
7. The *inferior mesenteric*, for the supply of the lower half of the large intestine.

8. The *lumbar*, four branches analogous to the intercostals, for the supply of the back part of the abdomen.

9. The *arteria sacra media*, which is given off at the bifurcation of the aorta, supplies the fifth lumbar artery and, running down in front of the sacrum, the lateral sacral arteries.

DISSECTION. These branches are to be traced throughout in the order most convenient. Take the cœliac axis first. To dissect this artery and its branches, the liver must be well raised, as in fig. 81, and the anterior layer of peritoneum removed from the gastro-hepatic omentum. A close network of very tough tissue surrounds the visceral branches of the aorta. This tissue consists almost entirely of plexuses of nerves, derived from the sympathetic system, each plexus taking the name of the artery which it surrounds. Of these plexuses, the largest surrounds the cœliac axis like a ring. This is the solar plexus, and is formed by the junction of the two semi-lunar ganglia (see dissection of thorax, p. 147). From this, as from a root, other secondary plexuses branch off, and surround the following arteries —the phrenic, coronary, hepatic, splenic, superior mesenteric, inferior mesenteric, and renal; the plexuses receiving the names of the arteries around which they twine. It requires a lean subject and much patience to trace them.

...a dextra, which runs along ...to left, and anastomoses ...lenic; and (β) the pancrea-...tween the head of the pan-...enum, and anastomoses with ...of the superior mesenteric. ...he right hepatic, divides into ...he under surface of the gall-



...OF THE BRANCHES OF THE CŒLIAC AXIS.

...as in dotted outline behind the stomach.)

...triculi.

5. Gastro-duodenalis.
6. Gastro-epiploica sinistra.
7. Vasa brevia.
8. Superior mesenteric a.

...other passes between the liver and the upper surface of the ...

The *splenic*, the largest of the three, proceeds tortuously towards the left side, above its corre-

PLAN OF THE BRANCHES OF THE CŒLIAC AXIS.

- Cœliac axis
  - Coronaria ventriculi.
    - œsophageal.
    - gastric.
  - Hepatic
    - pyloric.
    - gastro-duodenalis.
      - gastro-epiploica dextra.
      - pancreatico-duodenalis superior.
    - cystic.
  - Splenic
    - pancreatic branches.
    - gastro-epiploica sinistra.
    - vasa brevia to stomach.

Cœliac Axis and its Branches. The *cœliac axis* arises from the front of the aorta, between the pillars of the diaphragm, immediately above the upper border of the pancreas, and to the left of the lobulus Spigelii. It is a very thick, short trunk, which runs between the two layers of the lesser omentum, and, after a course of about half an inch, divides into three branches—the coronaria ventriculi, the splenic, and the hepatic.

Coronaria Ventriculi. The *coronaria ventriculi*, the smallest of the three, ascends a little to the left towards the œsophageal end of the stomach, where it gives off *œsophageal branches*, which inosculate with the œsophageal branches of the thoracic aorta. It then runs along the lesser curvature of the stomach towards the pylorus, and anastomoses with the pyloric branch of the hepatic artery.

Hepatic Artery. The *hepatic* artery ascends to the right between the layers of the lesser omentum to the transverse fissure of the liver, where it divides into two branches, right and left, for the supply of the respective lobes of the liver.

In its course to the liver, it lies to the left of the bile-duct, and in front of the portal vein; all three are contained in the right half of the lesser omentum. The hepatic gives off—

a. The *pyloric*, which runs along the upper curve of the stomach from right to left, and inosculates with the coronaria ventriculi.

b. The *gastro-duodenalis*, passing behind the ascending portion of the

duodenum, divides into (*a*) the gastro-epiploica dextra, which runs along the greater curve of the stomach, from right to left, and anastomoses with the gastro-epiploica sinistra from the splenic; and (β) the pancreatico-duodenalis superior, which runs down between the head of the pancreas and the descending portion of the duodenum, and anastomoses with the pancreatico-duodenalis inferior, a branch of the superior mesenteric.

c. The *cystic*, commonly a branch of the right hepatic, divides into two branches, one of which ramifies on the under surface of the gall-

FIG. 81.

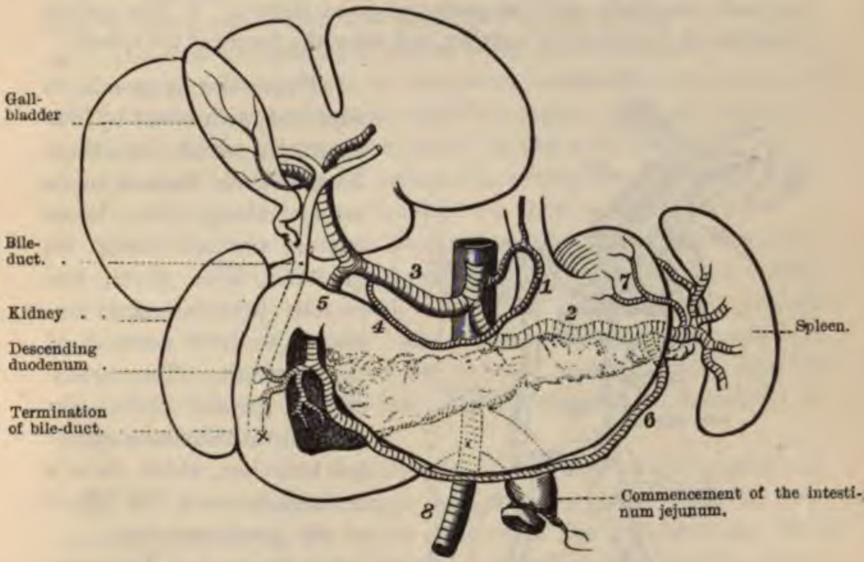


DIAGRAM OF THE BRANCHES OF THE CŒLIAC AXIS.

(Pancreas in dotted outline behind the stomach.)

1. Coronaria ventriculi.
2. Splenic a.
3. Hepatic a.
4. Pyloric a.
5. Gastro-duodenalis.
6. Gastro-epiploica sinistra.
7. Vasa brevia.
8. Superior mesenteric a.

bladder, the other passes between the liver and the upper surface of the gall-bladder.

SPLENIC ARTERY. The *splenic*, the largest of the three, proceeds tortuously towards the left side, above its corre-

sponding vein, along the upper border of the pancreas to the spleen, which it enters by numerous branches.

It gives off: 1. Several small branches to the pancreas, *pancreaticæ parvæ*. One, rather larger than the rest, which accompanies the pancreatic duct, is called *pancreatica magna*. 2. The *gastro-epiploica sinistra*, which runs to the right along the great curve of the stomach, and inosculates with the gastro-epiploica dextra. 3. *Vasa brevia*, which proceed between the layers of the *gastro-splenic* omentum, to the great end of the stomach, where they communicate with branches from the coronaria ventriculi, and the gastro-epiploica sinistra. 4. The *splenic* branches are five or six in number, and enter the fissure of the spleen.

FIG. 82.

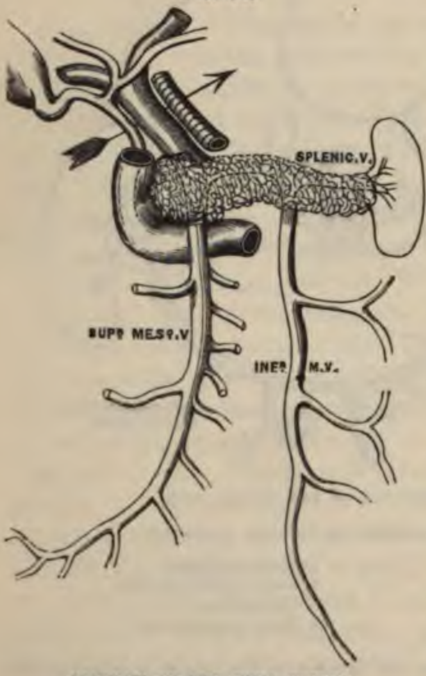


DIAGRAM OF THE VENA PORTÆ.
(The arrow is introduced behind the free border of the lesser omentum.)

Thus the stomach is supplied with blood by four channels, which by their inosculations form a main artery along its lesser curve, another along its greater; from these, numerous branches are furnished to both surfaces of the stomach. The artery of the greater curve also sends down numerous *omental* branches, which form a network between the layers of the great omentum.

VENA PORTÆ: ITS PECULIARITIES. The veins which return the blood from the abdominal portion of the alimentary canal, the pancreas, and the spleen, do not empty themselves into the vena cava inferior, but all unite into one large vein, called the *vena portæ*, which ramifies throughout the liver,

and secretes the bile. The trunk of the vena portæ itself is about three inches long. Tracing it downwards you find that it is formed behind the great end of the pancreas, by the confluence of the splenic and superior mesenteric veins (fig. 82). In its passage to the liver, the vena portæ is accompanied by the hepatic artery and the common bile-duct, lying behind and between them. At the transverse fissure of the liver it divides into two branches corresponding to the right and left lobes. The vein ramifies in the substance of the liver like an artery, and is surrounded, with the branches of the hepatic artery and duct, in a sheath of areolar or fibrous tissue called *Glisson's capsule*. The vena portæ may, then, be compared to the stem of a tree, of which the roots arise in the digestive organs, and the branches spread out in the liver. After receiving the veins corresponding to the branches of the hepatic artery, the vena portæ returns its blood into the inferior vena cava through the venæ cavæ hepaticæ.

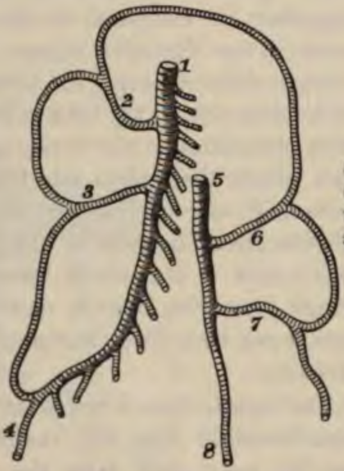
The veins which empty themselves into the vena portæ have no valves. Therefore, if any obstruction arise in the venous circulation through the liver, the roots of the portal vein are apt to become congested: this is a common cause of hæmorrhoids, diarrhœa, hæmorrhage from the bowels, and ascites. Leeches applied to the anus have been long recognised as beneficial in congestion of the liver.

BILE-DUCT. The hepatic duct is composed of two trunks, one from the right lobe and the other from the left: it is soon joined by the cystic duct from the gall-bladder. The common duct, *ductus communis choledochus*, thus formed, passes between the two layers of the lesser omentum close to its right border, then behind the first portion of the duodenum, and opens obliquely into the back part of the second portion, near the junction with the third. The duct runs through the coats of the bowel for nearly three-quarters of an inch (p. 387). As the common bile-duct descends between the layers of the lesser omentum, it lies in front of the vena portæ, having the hepatic artery on its left. The duct is about three inches long, and if distended would be about the size of a crow-quill.

DISSECTION. The great omentum, with the arch of the colon, must now be turned up over the chest, and the small intestines pushed towards the left side. Then, by removing the anterior layer of the peritoneum from the mesentery, we expose the mode in which the superior mesenteric artery ramifies so as to supply the small intestine. In making this dissection, the mesenteric glands immediately attract notice. They lie in great numbers between the layers of the mesentery, and vary considerably in size. The fine tubes, called lacteal vessels, which traverse

FIG. 83.

1. Superior mesenteric a.
2. Colica media.
3. Colica dextra.
4. Ileo-colica.



5. Inferior mesenteric a.
6. Colica sinistra.
7. Arteria sigmoidea.
8. Superior hæmorrhoidal a.

PLAN OF THE MESENTERIC ARTERIES, AND THEIR COMMUNICATIONS.

the glands, are too thin and transparent to be seen under ordinary circumstances. But in cases where sudden death has taken place during digestion, they are found distended with chyle, and can be traced into the glands from all parts of the small intestine.* After traversing the glands, they all eventually empty their contents into the receptaculum chyli (p. 142).

* The arrangement of the chyliferous vessels is well displayed in the plates of Mascagni.

Superior Mesenteric Artery and Branches. This large artery arises from the front of the aorta, descends beneath the pancreas, in front of the transverse part of the duodenum (p. 387), and then runs between the layers of the mesentery towards the right iliac fossa, where it terminates in branches for the supply of the cæcum. Thus it describes a gentle curve from left to right. It gives off the following branches :—

1. The *inferior pancreatico-duodenal* branch, which runs up, within the concavity of the duodenum, to inosculate with the *superior pancreatico-duodenal* branch of the hepatic. 2. *Vasa intestini tenuis* of the small intestine, from ten to sixteen in number, are given off from the left or convex side of the curve; while from the concave side come, 3. the *ileo-colic*; 4. the *right colic*; and 5. the *middle colic* for the supply of the ileum, cæcum, ascending, and transverse colon, respectively.

The student should now trace the branches to the small intestine, in order to see the series of arches which they form by their mutual inosculations. There are three or four tiers of them, each tier composed of smaller and more numerous branches than the preceding. The ultimate branches ramify in circles round the intestine. This circular arrangement of the vessels in the coats of the bowel is practically interesting, because it enables one in almost all cases to distinguish the intestine from the hernial sac.

The *colic* branches of the superior mesenteric are the *ileo-colic*, which is the continuation of the main trunk, and divides into two branches; one supplies the lower part of the ileum, and the other the cæcum :— the *right colic*, which proceeds towards the ascending colon, and the *middle colic*, which ascends between the layers of the meso-colon to the arch. They are arranged after the same plan as those of the small intestine : that is, they inosculate and form a series of arches which successively decrease in size and finally terminate in circles round the bowel.

The superior mesenteric *vein* joins the splenic behind the pancreas, and forms the vena portæ (p. 388).

DISSECTION OF THE INFERIOR MESENTERIC ARTERY AND BRANCHES.

To trace this artery, the small intestine must be drawn over towards the right side, and the peritoneum covering the artery removed. It is given off from the front of the aorta, about two inches above its bifurcation. Descending towards the left iliac fossa, it crosses obliquely over the left common iliac artery, passes between the layers of the meso-rectum, and, taking the name of *superior hæmorrhoidal*, is finally distributed to the upper part of the rectum. Its branches are:—

1. The *colica sinistra*, which crosses behind the peritoneum, over the left kidney, and supplies the descending colon.
2. The *sigmoidea*, which is distributed to the sigmoid flexure.
3. The *superior hæmorrhoidal*, which supplies the upper part of the rectum, and will be dissected with the side view of the pelvis.

These branches of the inferior mesenteric inosculate in the form of arches, like the colic branches of the superior mesenteric. The colica sinistra, too, forms a large arterial arch with the colica media, so that there is a chain of arterial communications from one end to the other of the intestinal canal (fig. 83).

The inferior mesenteric *vein* ascends nearly vertically in front of the left psoas, and joins the splenic behind the pancreas.

DISSECTION.

To see the relations of the duodenum and the pancreas, two ligatures about an inch apart should be placed on the upper end of the jejunum, and two others at a similar distance apart on the lower end of the sigmoid flexure of the colon. After the jejunum and the sigmoid flexure have been divided between the ligatures respectively, the small and large intestines can be removed. By turning up the stomach, we expose the duodenum curving round the great end of the pancreas.

DUODENUM, RELATIONS OF.

The duodenum (p. 387) commences at the pyloric end of the stomach, and terminates on the left side of the second lumbar vertebra, where the intestinum jejunum begins. It is divided into three parts, an ascending, descending, and transverse.

The first portion ascends obliquely as high as the neck of the gall-bladder; then making a sudden bend, it descends in front

of the right kidney as low as the third lumbar vertebra. Lastly, making another bend, it ascends obliquely across the spine to the left side of the second lumbar vertebra: here the intestine takes the name of jejunum. Thus the duodenum describes a horse-shoe curve, the concavity of which is directed towards the left side, and embraces the head of the pancreas.

The first or *ascending* portion is about two inches long, and is completely invested by peritoneum. It is comparatively free, so that the movements of the stomach may not be restricted. In front of it are the liver and gall-bladder. Behind it are the bile-duct and the hepatic vessels. The second or *descending* portion lies behind the transverse colon. Behind it are the common bile-duct and the pancreatic duct, which empty themselves into it either separately, or by a common opening. The descending portion is covered with peritoneum only on its anterior surface. The third or *transverse* portion is about four inches long, is situated behind the transverse meso-colon, just above the mesentery, and below the superior mesenteric artery and the pancreas. It lies upon the aorta and inferior vena cava. This portion, like the second, is only covered in front by peritoneum. Notice how firmly the duodenum is braced up on the left side of the second lumbar vertebra; and how the jejunum begins here by an abrupt downward bend.

PANCREAS, RELATIONS OF. This large gland is situated immediately behind the stomach (p. 378.) It is of an elongated form, and of pinkish-white colour. It is placed transversely across the spine; its larger end, or *head*, is embraced by the duodenum; its lesser end, or *tail*, is in contact with the spleen. The splenic artery and vein run along the upper border of the gland, and above it is the cœliac axis; the lower border is in relation with the transverse portion of the duodenum, from which it is separated by the superior mesenteric vessels. Posteriorly, the pancreas rests upon the inferior vena cava, the left kidney, the left supra-renal capsule, the commencement of the vena portæ, the aorta, the crura of the diaphragm, the superior mesenteric vessels and the inferior mesenteric vein. Its duct runs from left

to right, near the lower border and anterior surface of the gland, and empties itself into the back part of the descending portion of the duodenum, conjointly with, or close to, the opening of the common bile-duct. It receives numerous branches from the splenic artery, which runs along its upper border; some from the superior mesenteric, which lies immediately beneath it, and others from the gastro-duodenalis.

DISSECTION. The liver, stomach, duodenum, pancreas, and spleen should now be collectively removed. For this purpose it is necessary to cut through the ligaments of the liver, the venæ cavæ hepaticæ, and the branches of the cœliac axis. These viscera, with the remainder of the intestinal canal, should be macerated in water, while you examine all that is to be seen at the back of the abdomen: namely, the deep-seated muscles, the aorta, the inferior vena cava, the kidneys, the lumbar plexus of nerves, and the sympathetic nerve.

KIDNEYS AND URETER, RELATIONS OF. The kidneys are situated in the lumbar region, behind the peritoneum, one on each side of the spine. They lie embedded in more or less fat, on the quadratus lumborum, the psoas, and the crura of the diaphragm. The right is somewhat the lower of the two. Surmounting each is a small body, called the supra-renal capsule. The excretory duct of the kidney, the ureter, descends almost vertically on the psoas muscle, enters the pelvis over the division of the common iliac artery, and empties itself into the lower part of the bladder after running obliquely through its coats. The right kidney is in contact, above, with the under surface of the liver, and its upper end reaches as high as the lower border of the eleventh rib; the left is in contact above with the spleen, and reaches to the level of the upper border of the eleventh rib.

In front of the *right* kidney are the liver, the ascending colon, the descending portion of the duodenum, and the colica dextra artery; in front of the *left*, the descending colon, part of the spleen, the pancreas, and the colica sinistra artery. This explains how it is that a renal abscess or calculus is sometimes evacuated by the rectum.

The outer border of the kidney is convex, the inner concave, and presents a notch, the hilus, for the entrance of the vessels and duct, which have the following relations:—anteriorly is the renal vein, posteriorly is the ureter, the renal artery being between them.

DISSECTION. The kidneys and supra-renal capsules must be removed and reserved for further examination.

SEMILUNAR GANGLIA. The *semilunar ganglia*, two in number, are situated one on each side of the cœliac axis, in the neighbourhood of the supra-renal bodies; that on the right side will be found lying under the vena cava inferior. Their filaments

FIG. 84.

1. Aorta passing between the crura.
2. Opening for œsophagus.
3. Opening for vena cava.

4. Quadratus lumborum.
5. Psoas magnus. The dark arches above the quadratus and psoas are the 'arcuate ligaments.'

DIAGRAM OF THE DIAPHRAGM, THE OPENINGS IN IT, AND THE PHRENIC ARTERIES.

are distributed to the supra-renal and renal plexuses, and to the plexuses which surround the branches of the abdominal aorta. Above, each ganglion receives the great splanchnic nerve (p. 147).

DIAPHRAGM. This is a partly muscular and partly tendinous arch, so constructed as to form a complete movable partition between the chest and the abdomen; a floor for the one, and a roof for the other. Its upper or thoracic surface is convex; its lower or abdominal, concave. On removing its peritoneal covering, we observe a broad tendon in the centre, and that muscular fibres converge to it from all sides (fig. 84). The diaphragm *arises*, 1. From the ensiform cartilage; 2. From the inner

surfaces of the cartilages of the six lower ribs by as many digitations, which correspond with those of the transversalis; 3. From two thin tendinous arches, called, respectively, the *ligamenta arcuata*, *externum* and *internum* (the external arch extends from the last rib to the transverse process of the first lumbar vertebra, and arches over the quadratus lumborum; the internal passes from the transverse process of the first lumbar vertebra to the body of the same vertebra, and arches over the psoas); and 4. From the front of the bodies of the lumbar vertebræ by two elongated bundles, called the *crura* of the diaphragm. Both crura have tendinous origins; the right crus is, however, a little longer than the left; the former arises from first, second, and third lumbar vertebræ and their intervening cartilages, the left does not descend so low by one vertebra. The inner fibres of each crus decussate; those of the right being the more anterior. In their decussation the fibres separate the aortic from the œsophageal openings. Between the two crura the aorta enters the abdomen.

From these various origins the fibres ascend, at first nearly vertically, and then all arch inwards, and converge to be *inserted* into the central tendon.

The *central tendon* is nearly the highest part of the diaphragm. It presents a white glistening surface, owing to the crossing of its tendinous fibres; and its shape may be compared to that of a trefoil leaf. The chief point of interest about the tendon is that, in consequence of its connections with the pericardium, below which it lies (p. 134), it is always maintained nearly on the same level; so that it helps to support the heart, and serves as a fixed point for the insertion of the muscular fibres of the diaphragm.

OPENINGS IN THE DIAPHRAGM. There are three large openings in the diaphragm for the transmission of the aorta, the œsophagus, and the inferior vena cava, respectively. The *aortic opening* lies between the crura in front of the spine; it transmits, also, the vena azygos and the thoracic duct, both of which lie rather to the right side of the aorta. Trace the crura upwards, and observe that the inner fibres of each cross each other in front of the aorta,

somewhat like the letter X.* Above the decussation, and a little to the left of it, is the *œsophageal opening*; this is oval and entirely muscular, and transmits the œsophagus and the pneumogastric nerves. The *opening* for the *vena cava* (*foramen quadratum*) is situated in the highest part of the central tendon, rather to the right of the middle line. Observe that the vein is intimately connected to its margin, and kept permanently open. Lastly, there pass through the crus, on each side, the sympathetic and the greater and lesser splanchnic nerves. The arch of the diaphragm, in expiration, extends about as high as the fifth rib on the right side, and the sixth rib on the left.

Fig. 85.

DIAPHRAGM FROM ITS UPPER SURFACE.

(The dotted lines show the amount of descent on contraction.)

The nerves of the diaphragm are the phrenic (p. 132), and the five or six lower intercostal nerves. The diaphragm also receives minute filaments from the diaphragmatic plexus, which comes from the semilunar ganglia. On its under surface on the right side, close to the supra-renal capsule, the plexus joins some branches of the right phrenic nerve, at which spot there is a small ganglion (*ganglion diaphragmaticum*), from which filaments are given off to the liver, vena cava and supra-renal capsule. It is absent on the left side. Its blood-vessels are the two phrenic, derived from the aorta, the internal mammary (p. 121), and the lower intercostal.

FUNCTION OF THE DIAPHRAGM. The diaphragm is the great muscle concerned in inspiration. It may be said with Haller, that it

* This decussation is not always complete. But the right crus always crosses more or less over the left, so that the crura are never strictly parallel.

is 'musculus post cor nobilissimus.' During inspiration the muscular sides of the diaphragm contract, and become less arched (as shown by the dotted line in fig. 85); the floor of the chest sinks in consequence, and more room is made for the expansion of the lungs. During expiration the diaphragm relaxes, and the air is expelled, partly by the elasticity of the lungs and the thoracic walls, partly by muscular action. This alternate sinking and rising of the diaphragm constitutes a chief part of the mechanism of breathing. But the diaphragm conduces to the performance of many other functions. Acting in concert with the abdominal muscles, it assists in the expulsion of the fæces and the urine, also in parturition and in vomiting: for in all these operations we first take in a deep breath, that the diaphragm may be in a state of contraction, and so form a resisting surface, against which the viscera may be compressed by the abdominal muscles. Moreover, by its rapid or spasmodic contractions it is one of the chief agents concerned in laughing, sneezing, coughing, hiccough.

DISSECTION. The muscles and nerves at the back of the abdomen must be carefully cleaned; also, the abdominal aorta, and vena cava inferior in front of the spine, without injuring the sympathetic nerves, situated on each side of the bodies of the vertebræ. The sheath which invests the psoas should be examined, and the branches of the lumbar plexus preserved as they emerge from the outer part of the muscle.

The sheath of the psoas is attached to the sides of the vertebræ, the brim of the pelvis, and above to the ligamentum arcuatum internum. It is this sheath which determines the ordinary course of psoas abscess: namely, beneath the crural arch into the upper part of the thigh; for it is a rare exception when the matter travels into the pelvis.

PSOAS MAGNUS. This long muscle *arises* by five muscular fasciculi from the transverse processes of all the lumbar vertebræ, also from the bodies of the last dorsal, and all the lumbar vertebræ and their intervening fibro-cartilages; but only from the projecting borders of the bodies, not from the central grooved part: here the fibres arise from tendinous arches

thrown over the lumbar vessels. The muscle descends vertically along the brim of the pelvis, beneath the crural arch into the thigh, and is *inserted* by a strong tendon into the back part of the lesser trochanter of the femur. In front, the psoas has in relation with it the ligamentum arcuatum internum, the external iliac artery, the kidney and the ureter, the spermatic vessels, the genito-crural nerve and the vas deferens; behind it, are the ilium, the quadratus lumborum, the lumbar plexus of nerves, and the obturator nerve which, lower down, runs along the inner border of the muscle. Towards its insertion, the tendon of the psoas lies between the iliacus and the pectineus.

As it passes under the crural arch, the tendon of the psoas lies immediately over the capsule of the hip-joint, and there is a large bursa between them to facilitate the play of the tendon. It should be borne in mind that occasionally, even in young subjects, but more frequently in old ones, in consequence of wear and tear, this bursa communicates with the hip-joint. The fact is important; for it explains how a psoas abscess sometimes makes its way into the hip-joint: a result frequently fatal.

PSOAS PARVUS. Once in about eight or ten subjects there is a small muscle called the *psoas parvus*. It *arises* from the bodies of the last dorsal and the first lumbar vertebræ, and the intervening fibro-cartilage; thence descending in front and to the inner side of the psoas magnus, it ends in a long flat tendon, which spreads out, and is *inserted* into the linea ilio-pectinea.

ILIACUS INTERNUS AND ILIAC FASCIA. This muscle occupies the iliac fossa, and is covered by the iliac fascia. This *iliac fascia* is attached to the crest of the ilium, and indirectly to the brim of the pelvis through its connection with the sheath of the psoas. Its most important attachment is to the outer half of the crural arch; here it is directly continuous with the fascia transversalis (p. 365), so that, together, they present an effectual barrier to the escape of intestine beneath this part of the arch.* The external iliac artery

* The iliac fossæ are liable to be the seat of suppuration, and the course which the pus takes depends upon its position with regard to the iliac fascia. If the pus be seated in the loose cellular tissue between the peritoneum and the fascia, it

and vein lie in front of the fascia, while the anterior crural nerve is behind it.

The *iliacus internus* arises from the iliac fossa, from the ilio-lumbar ligament,* and from the capsule of the hip-joint. The fibres converge beneath the crural arch, and are *inserted* mainly into the outer side of the tendon of the psoas, and partly into the triangular surface of the femur, below and anterior to the lesser trochanter. Thus the two muscles, so far as their action goes, may be considered as one, and are sometimes called the ilio-psoas.

The combined *action* of the psoas and iliacus is to assist in raising the body from the recumbent position, and to fix the pelvis steadily on the thigh: this supposes the fixed point to be at the trochanter minor. If the fixed point be at the spine, then the muscle flexes and rotates the femur outwards. It is this action which often occasions so much displacement in fractures of the upper third of the femur.

QUADRATUS LUMBORUM AND ITS SHEATH. This muscle extends from the crest of the ilium to the last rib, and is contained in a sheath formed for it by the aponeurotic origin of the transversalis (p. 361). The anterior layer of its sheath is attached to the roots of the *transverse* processes of the lumbar vertebræ, and the posterior layer to their summits. The muscle, broader below than above, *arises* from the ilio-lumbar ligament and from the crest of the ilium for two inches external to it. It is *inserted* into the last rib, and by tendinous slips into the transverse processes of the upper four lumbar vertebræ. Besides the preceding, a few fibres of the muscle arise from the transverse processes of the third, fourth and fifth lumbar vertebræ, and, running up in front of the others, are inserted in common with them. The principal use of the muscle is to steady the spine; it also steadies the last

usually advances just above the crest of the ilium, or towards the groin through the inguinal canal; but, if seated beneath the fascia, the matter usually makes its way under the crural arch towards the upper and outer part of the thigh.

* This ligament extends from the transverse process of the last lumbar vertebra to the ilium.

rib, and enables it to serve as a fixed point for the action of the intercostal muscles and the diaphragm.*

By raising the quadratus, we observe the aponeurotic origin of the transversalis from the summits of the transverse processes: this constitutes the posterior part of its sheath, and separates the muscle from the erector spinæ.

Before examining the course of the aorta and its great primary divisions, notice that a chain of lymphatic glands extends along the brim of the pelvis and the bodies of the lumbar vertebræ, following the course of the great blood-vessels. Generally speaking they are small; only one here and there attracts observation. They transmit the lymphatics from the lower limbs, the abdominal wall, and the testicle; and all eventually lead to the *receptaculum chyli*, or beginning of the thoracic duct (p. 142). This is usually found on the right of the aorta, close to the second lumbar vertebra.

RELATIONS OF THE ABDOMINAL AORTA.

The aorta enters the abdomen between the crura of the diaphragm in front of the last dorsal vertebra, and descends a little to the left side of the front of the spine, as low as the middle of the fourth lumbar vertebra, where it divides into the two common iliac arteries. The division is about the level of the highest point of the crest of the ilium, and just below the left side of the umbilicus. The aorta is crossed in front by the splenic vein, the pancreas, the transverse portion of the duodenum, the left renal vein, the mesentery; and it has also in front of it a chain of lymphatic glands. To the right side of it lie the vena cava inferior, the thoracic duct, the vena azygos, and the right crus of the diaphragm. To the left side of it is the left crus, and on each side are the sympathetic nerves.

* The respective attachments of the quadratus lumborum, the crossing of its fibres, and its mode of action, lead to the inference that it is a large intercostal muscle. It is worth remembering that the outer edge of the quadratus lumborum, in a well-grown adult, is about three inches from the spines of the lumbar vertebræ, and midway between the last rib and the crest of the ilium. It is just outside the edge of this muscle that we can cut down to open the large bowel without wounding the peritoneum.

The branches of the aorta still to be examined arise from it in pairs—namely, the phrenic, capsular, renal, spermatic, and lumbar. (See diagram p. 384.)

PHRENIC ARTERIES. These arteries supply the under surface of the diaphragm, and arise separately, or by a common trunk, from the aorta after its passage under the pillars (p. 396). The *right phrenic* passes outwards, behind the vena cava, the left behind the œsophagus; each ascends, lying on its corresponding crus, as far as the central tendon, where each divides into two branches: one which passes transversely across the tendon to the side of the diaphragm; the other, which seems to be the continuation of the artery, runs forwards to the anterior part of the muscle. Their first branches are to the supra-renal capsules; then the right gives off a small branch to the vena cava, the left, one to the œsophagus. They inosculate with each other, with the internal mammary, and the intercostal arteries. The right phrenic *vein* terminates in the inferior vena cava; the left, in the renal vein, if not in the vena cava.

SUPRA-RENAL ARTERIES. The *supra-renal* or *capsular* arteries are two very small branches, given off from the aorta opposite to the superior mesenteric artery; each runs upon the crus of the diaphragm, the right behind the inferior cava, and is distributed to the supra-renal body, inosculating with branches from the phrenic and renal arteries. The right capsular *vein* terminates in the inferior vena cava, the left in the left renal.

RENAL ARTERIES AND VEINS. The *renal* arteries arise from the aorta at right angles, and run transversely to the kidneys. Both are covered by their corresponding veins. The right is longer and rather lower than the left, and passes beneath the vena cava. Each, after sending a small branch to the supra-renal body, enters its kidney, not as a single trunk, but by several branches, corresponding to the original lobes of the organ. The renal *veins* lie in front of the arteries, and join the vena cava at right angles. The left is longer than the right, and crosses over the aorta; it also receives the spermatic, capsular, and sometimes the phrenic veins of its own side.

SPERMATIC ARTERIES AND VEINS.

The *spermatic* arteries, two in number, arise from the front of the aorta, a little below the renal. Each runs down upon the psoas, crossing over the ureter and over the front of the external iliac artery immediately above the crural arch. Each then passes through the internal abdominal ring and inguinal canal, with the other constituents of the spermatic cord to the testicle. Each artery is accompanied by two very tortuous *veins*, which unite before they empty themselves, on the right side into the vena cava, on the left, into the renal vein. In the female, the *ovarian* arteries do not leave the abdomen, but pass, between the layers of the broad ligaments, to the ovaries.

LUMBAR ARTERIES AND BRANCHES.

There are five of these arteries on either side: four arise from the aorta, the fifth comes from the arteria sacra media. They are analogous to the intercostal arteries on a small scale. They proceed outwards over the bodies of the vertebræ, beneath the arch formed by the psoas muscle, towards the intervertebral foramina, and then, like the intercostals, divide into dorsal and abdominal branches. The two upper lumbar arteries pass beneath the crura of the diaphragm, those on the right side being also behind the vena cava.

The *dorsal* branches pass between the transverse processes of the vertebræ, accompanied by the posterior branches of the corresponding nerves, and are of a size proportionate to the large development of the muscles of the back which they supply. They also send *spinal branches*, which enter the spinal canal through the intervertebral foramina; some of these are distributed to the anterior part of the cauda equina, and others to the bodies of the lumbar vertebræ, forming a series of arches behind them.

The *abdominal* branches all run outwards behind the quadratus lumborum, except the last, which usually runs in front. After supplying the quadratus and psoas, they pass forwards between the abdominal muscles and supply the walls of the abdomen.* They

* Just as the thoracic intercostals, by communicating with the internal mammary, form an arterial ring round the chest, so do the lumbar, by communicating with the epigastric, form a similar, though less perfect, ring round the walls of the abdomen.

anastomose, laterally, with the ilio-lumbar and circumflex iliac arteries, and, in front, with the internal mammary and epigastric arteries.

The lumbar *veins* empty themselves into the vena cava inferior.

The *arteria sacra media*, a diminutive continuation of the aorta, proceeds from its bifurcation, and runs down in front of the sacrum to the coccyx. It sends off the fifth lumbar artery, and lateral branches, which anastomose with the lateral sacral arteries; it also supplies small vessels to the posterior part of the rectum. Its *vein* empties itself either into the left common iliac vein, or into the inferior vena cava. In animals it is the artery of the tail.

VENA CAVA INFERIOR. The vena cava inferior is formed by the junction of the two common iliac veins, a little to the right side of the fifth lumbar vertebra. It ascends on the right of the aorta, close to the spine in the greater part of its course. As it approaches the diaphragm, the vena cava inclines a little to the right, separated from the aorta by the right crus, to go through its tendinous opening in the diaphragm, and reach the right side of the heart. Its relations, beginning from below, are—in front, the mesentery, the third part of the duodenum, the pancreas, the liver, and the right spermatic artery; behind it are the right renal artery, the right lumbar arteries, and the sympathetic of the right side. It receives the lumbar veins, the right spermatic (the left joins the renal), the renal, the capsular, the right phrenic, and the hepatic veins.

COMMON ILIAC ARTERIES AND VEINS. The aorta divides, in front of the fourth lumbar vertebra, into two great branches, termed the common iliac arteries. They diverge at an acute angle, and, after a course of about two inches, each divides over the sacro-iliac symphysis, into the external and internal iliac. They lie upon the bodies of the fourth and fifth lumbar vertebræ. They are covered by peritoneum, and crossed, at or near their division, by the ureters. They are also crossed by branches of the sympathetic on their way to the hypogastric plexus. So far, then, the relations

of both common iliac arteries are similar. But each has its special relations as follows:—

The special relations of the right common iliac are, that it lies, at its commencement, close to the left of the inferior vena cava; and that it subsequently *crosses over both the common iliac veins.*

The special relations of the left common iliac are, that it has, in front of it, the end of the sigmoid flexure of the colon and the inferior mesenteric vessels; and, to its right side, the common iliac vein, which gradually gets more behind it towards the sacro-iliac symphysis.

The relations of these arteries with regard to their corresponding veins are, practically, important in reference to the operation of tying them. This operation is, obviously, easier on the left side than the right.*

If the common iliac artery were ligatured, the collateral circulation would be maintained through the following vessels: by the internal mammary anastomosing with the deep epigastric a.; by the lumbar arteries with the circumflex iliac and the ilio-lumbar a.; by the lumbar with the gluteal; by the middle sacral with the lateral sacral a.; by the spermatic with the deferential, cremasteric, external pudic and superficial perineal arteries; by the superior hæmorrhoidal with the middle and inferior hæmorrhoidal a.; by the lower intercostals with the epigastric a. (superficial and deep); and by the middle and the inferior hæmorrhoidal, the pudic and its branches, and the vesical arteries communicating in the middle line with the corresponding branches of the opposite side.

EXTERNAL ILIAC ARTERY. The *external iliac* artery passes along the brim of the pelvis, first on the inner side, and then in

* The length of the common iliac artery is apt to vary in different persons. We have seen it from three-fourths of an inch to three and a half inches long. These varieties may arise either from a high division of the aorta, or a low division of the common iliac, or both. It is impossible to ascertain, beforehand, its length in any given instance, as there is no necessary relation between its length and the height of the adult individual. It is often very short in men of tall stature, and *vice versâ.* The left is usually described as rather longer than the right; but, from the examination of 100 bodies, our conclusion is that their average length is the same.

front of the psoas. Lower down it passes under the crural arch, midway between the anterior superior spine of the ilium and the symphysis pubis, and takes the name of *femoral*. The artery has in front of it the peritoneum, and intestine; and, just above Poupart's ligament, the deep circumflexa ilii vein, the spermatic vessels, and the vas deferens. On its inner side, and on a plane somewhat posterior, is the corresponding vein. The iliac fascia lies behind the vessels, but a thin layer of fascia derived from it is continued over them. In front of the artery are a chain of lymphatic glands.

The branches given off by this artery are :—

The deep *epigastric*, already described (p. 366).

The deep *circumflexa ilii*, which arises from the outer side of the artery, just above the crural arch, and running towards the anterior superior spine of the ilium in a sheath formed by the fascia iliaca, subsequently perforates the transversalis muscle.* In the dissection of the abdominal muscles (p. 367), the continuation of it was seen skirting the crest of the ilium between the internal oblique and the transversalis, and sending a branch upwards between these muscles for their supply. The main trunk, much reduced in size, inosculates with the ilio-lumbar derived from the internal iliac.

LIGATURE OF THE EXTERNAL ILIAC.

The best way of tying the external iliac is to make a curved incision at the lower part of the abdomen, beginning a little above the middle of the crural arch, and ending about an inch to the inner side of the spine of the ilium. The strata of the abdominal muscles, with the fascia transversalis, should then be divided to the same extent; after which, the peritoneum with the spermatic vessels must be separated by the fingers from the iliac fossa. It is necessary to make a small incision through the sheath of the vessel, to facilitate the passage of the needle. Remember that the vein is closely connected to its inner side,† that the genito-crural nerve is not

* The course of this artery should be borne in mind in opening iliac abscesses.

† This relative position of the vessels does not always exist. In old subjects, less frequently in adults, it is sometimes found that the external iliac artery runs very

far off, and that the circumflex iliac vein crosses the artery just above Poupart's ligament.

After ligature of the artery the collateral circulation would be maintained by anastomoses between the internal mammary and the deep epigastric; between the lumbar arteries and the circumflex iliac; between the pubic branch of the obturator and the branch of the epigastric; between the gluteal and the internal and external circumflex; between the sciatic and the first perforating and the internal circumflex; between the obturator and the internal circumflex; between the spermatic, the deferential, and the cremasteric and the external pudic; between the lower intercostals and the lumbar arteries and the epigastric artery.

SYMPATHETIC NERVE. The general plan upon which the sympathetic nerve is arranged has been noticed in the dissection of the neck (p. 114). The lumbar portion of it must now be examined.

The abdominal part of the sympathetic descends on either side in front of the bodies of the lumbar vertebræ, along the inner border of the psoas. The nerve has an oval ganglion opposite each lumbar vertebra, so that there are five on each side. These ganglia are connected by small filaments, and each ganglion receives two branches from the corresponding spinal nerve, as in the chest.

SOLAR PLEXUS AND THE SEMI-LUNAR GANGLIA. The *solar plexus* is situated in front of the aorta and surrounds the cœliac axis in a dense network of nerve-filaments, on which are several

tortuously, instead of nearly straight, along the brim of the pelvis. But the vein does not follow the artery in its windings, and may possibly lie outside the artery just where we propose to place the ligature.

The mode of performing the operation described in the text is recommended by Sir A. Cooper. Mr. Abernethy, however, who first set the example of tying this artery, in 1796, adopted a somewhat different proceeding. He says: 'I first made an incision about three inches in length through the integuments of the abdomen, in the direction of the artery, and thus laid bare the aponeurosis of the external oblique muscle, which I next divided from its connection with Poupart's ligament, in the direction of the external wound, for the extent of about two inches. The margins of the internal oblique and transversalis muscles being thus exposed, I introduced my finger beneath them for the protection of the peritoneum, and then divided them. Next, with my hand, I pushed the peritoneum and its contents upwards and inwards, and took hold of the artery.'

ganglia. It receives the splanchnic nerves, and some branches from the pneumogastric nerves; and it gives off filaments which surround the various branches of the abdominal aorta, the plexuses thus formed taking the name of the arteries they accompany.

The *semilunar ganglia* are situated, one on each side of the cœliac axis, and internal to the supra-renal capsules. These ganglia have been described (p. 395).

The plexuses connected with these nervous centres are,—the diaphragmatic, the superior mesenteric, the supra-renal, the renal, the spermatic, the coronary hepatic and splenic, the aortic, and the inferior mesenteric.

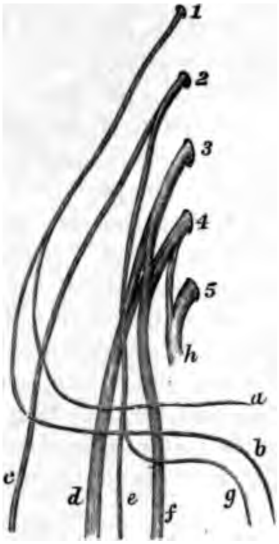
HYPOGASTRIC PLEXUS. The *hypogastric plexus* is situated between the common iliac arteries, on the last lumbar vertebræ and the sacrum. It consists of an intricate interlacement of sympathetic filaments, which pass down into the pelvis, for the supply of the pelvic viscera. Although this plexus is so intricate, it presents no distinct ganglia. As it passes down it receives branches from some of the spinal nerves, but mainly from the third and fourth sacral nerves. From this large plexus are derived secondary plexuses, which ramify around branches of the internal iliac artery: thus there are, the inferior hæmorrhoidal plexus, the vesical, the uterine, the ovarian, the prostatic, and the vaginal; all of which send filaments which accompany the smallest branches of the arteries.

LUMBAR PLEXUS OF NERVES. The lumbar plexus is formed by the union of the anterior branches of the four upper lumbar nerves. The fifth does not enter into the formation of this plexus, but joins the sacral plexus under the name of the lumbo-sacral cord. The plexus lies over the transverse processes of the corresponding vertebræ, embedded in the substance of the psoas, so that this muscle must be dissected away before the plexus can be seen. Like the brachial plexus, the nerves composing it successively increase in size from above. Its branches are five in number, and arise in the following order (fig. 86).

a. The *first lumbar* nerve generally divides into two branches;

the upper being the ilio-hypogastric, the lower the ilio inguinal. They cross obliquely over the quadratus lumborum to the crest of the ilium, and then separate. The *ilio-hypogastric* passes forwards to the crest of the ilium, where it pierces the transversalis, and divides into its two terminal branches—the *iliac* branch, which supplies the skin over the glutæal region, behind the last dorsal nerve, and the *hypogastric* branch, which runs forward between the transversalis and internal oblique, and then perforates the aponeu-

Fig. 86.



a. Ilio-hypogastric n.
b. Ilio-inguinal n.
c. External cutaneous n.
d. Anterior crural n.
e. Crural branch of genito-crural n.
f. Obturator n.
g. Genital branch of genito-crural n.
h. Lumbo-sacral n.

1. First lumbar n.
2. Second " "
3. Third " "
4. Fourth "
5. Fifth "

PLAN OF THE LUMBAR PLEXUS AND BRANCHES.

rosis of the external oblique to supply the skin. The *ilio-inguinal*, the smaller, perforates the transversalis and internal oblique, comes out through the external abdominal ring in front of the spermatic cord, and supplies the skin of the penis and scrotum in the male, and the labium in the female.

b. The *genito-crural nerve* is small, and comes from the second lumbar. After perforating the psoas, it runs down along the outer side of the external iliac artery, and near the crural

arch divides into the *genital* branch (g), which runs along the inguinal canal, on the under aspect of the spermatic cord, and supplies the cremaster; and the *crural* (e), which proceeds under the crural arch, and is lost in the skin of the upper part of the thigh, where it communicates with the middle cutaneous nerve.

c. The *external cutaneous nerve of the thigh* is generally derived from the second lumbar. It runs through the psoas, then, crossing obliquely over the iliacus towards the spine of the ilium, passes beneath the crural arch, and is finally distributed to the skin on the outside of the thigh. If the external cutaneous be not found in its usual situation, look for it as a distinct branch of the anterior crural, nearer the psoas muscle.

d. The *anterior crural* (d), the largest and most important branch, is formed by the union of the third and fourth lumbar nerves, sometimes receiving a small branch from the second. It descends in a groove between the psoas and the iliacus behind the fascia iliaca, supplies both these muscles, and then, passing under the crural arch to the outer side of the femoral artery, is finally distributed to the extensor muscles of the knee, to the sartorius and pectineus, and the skin of the thigh and leg.

e. The *obturator nerve* (f) is next in size to the anterior crural. It proceeds from the third and fourth lumbar nerves, descends behind the psoas muscle, and then, getting to its inner border it runs along the brim of the pelvis to the obturator foramen, through the upper part of which it passes to the adductor muscles of the thigh.

f. The *accessory obturator nerve*, by no means a constant branch, is derived from the third and fourth lumbar nerves. It descends over the horizontal ramus of the pubes, supplies the pectineus and gives off a small branch to the hip joint.

Postponing the minute anatomy of the abdominal viscera, begin the examination of the contents of the pelvis.

DISSECTION OF THE PELVIC VISCERA.

The functions of the pelvis are to protect its own viscera; to support those of the abdomen; to give attachment to the muscles which steady the trunk; to transmit the weight of the trunk to the lower limbs, and to give origin to the muscles which move them. In adaptation to these functions, the form of the pelvis is that of an arch, with broadly expanded wings at the sides, and projections in appropriate situations to increase the leverage of the muscles. The sacrum, impacted between the ilia, represents the key-stone of the arch, and is capable of supporting not only the trunk, but great burdens besides. The sides or pillars are represented by the ilia; these transmit the weight to the heads of the thigh-bones, and are thickest and strongest just in that line, i.e. the brim of the pelvis, along which the weight is transmitted. Moreover, to effect the direct transmission of the weight, the plane of the arch is oblique. This obliquity of the pelvis, its hollow expanded sides, its great width, the position and strength of the tuberosities of the ischia, are so many proofs that man is adapted to the erect posture.

The general conformation of the pelvis in the female is modified, so as to be adapted to utero-gestation and parturition. Its breadth and capacity are greater than in the male. Its depth is less. The alæ of the iliac bones are more expanded. The projection of the sacrum is less perceptible, and consequently the brim is more circular. The span of the pubic arch is wider. The bones, too, are thinner, and the muscular impressions less strongly marked.

The cavity of the pelvis being curved, the axis, or a central line drawn through it, must be curved in proportion. For all practical purposes, it is sufficient to remember that the axis of the pelvis corresponds with a line drawn from the anus to the umbilicus.*

* In a well-formed female the base of the sacrum is about four inches higher than the upper part of the symphysis pubis, and the point of the coccyx is rather more than half an inch higher than the lower part of the symphysis.

The obliquity of the pelvis is greatest in early life. In the fœtus, and in young

CONTENTS OF THE MALE PELVIS. The male pelvis contains the last part of the intestinal canal, named the rectum, the bladder with the prostate gland at the neck, and the vesiculæ seminales. If the bladder be empty, some of the small intestine will be in the pelvis; not so if the bladder be distended.

COURSE OF THE RECTUM. The rectum enters the pelvis on the left side of the sacrum, and, after describing a curve corresponding with the concavity of the sacrum, terminates at the anus. In the first part of its course, it is loosely connected to the back of the pelvis by a peritoneal fold, called the *meso-rectum*: between the layers of this fold, the superior hæmorrhoidal vessels, the continuation of the inferior mesenteric, with nerves and lymphatics, runs to the bowel.

The rectum does not take this course in all cases; sometimes it makes one, or even two lateral curves. In some rare cases it enters the pelvis on the right side instead of the left. Since these variations from the usual arrangement cannot be ascertained during life, they should make us cautious in the introduction of bougies.*

RECTO-VESICAL POUCH. Whilst the parts are still undisturbed, introduce the finger into the *recto-vesical peritoneal pouch* (fig. 87). This is a cul-de-sac formed by the peritoneum in passing from the front of the rectum to the lower and back part of the bladder. In the adult male, the bottom of this pouch is about one inch distant from the base of the prostate gland:† therefore part of the under surface of the bladder is not covered by peritoneum; and since this part is in immediate contact with the rectum, it is practicable to tap the distended bladder through the front of the bowel without injuring the peritoneum. The operation has, of late

children, its capacity is small; and the viscera, which subsequently belong to it, are situated in the abdomen.

* In old age the rectum has sometimes a zigzag appearance immediately above the anus. These lateral inclinations are probably produced by the enormous distensions to which the bowel has been occasionally subjected.

† The bottom of the pouch is from three to four inches distant from the anus.

years, been revived, and with great success.* It is easily done, and not attended with risk, provided all the parts be in their regular position. But this is not always the case. It sometimes happens that the peritoneal pouch comes down nearer to the prostate than usual—we have seen it in actual contact with the gland; so that, in such a case, it would be impossible to tap the bladder from the rectum without going through the peritoneum. In children the peritoneum comes down lower than it does in the adult, because the bladder in the child is not a pelvic viscus.

FIG. 87.

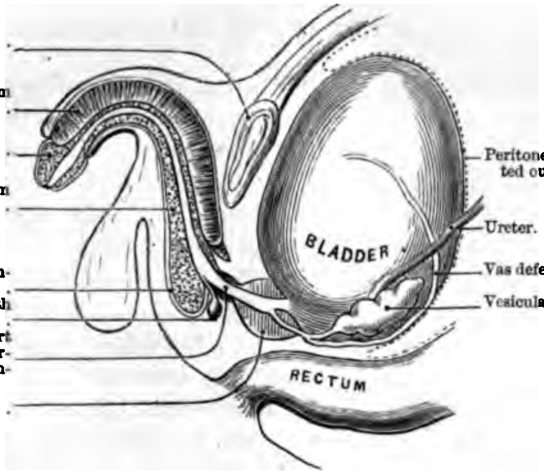


DIAGRAM OF THE RELATIVE POSITION OF THE PELVIC VISCERA.

The recto-vesical pouch is permanent. But there is another peritoneal pouch on the front part of the bladder, which is only produced when the bladder is distended. To produce it, the bladder should be blown up through one of the ureters. The bladder soon fills the pelvis, and then, rising into the abdomen, occasions the pouch between it and the abdominal wall. At first, the pouch is shallow, but it gradually deepens as the bladder

* See a paper in the 'Med. Chir. Trans.' vol. xxxv. by Mr. Cock.

rises. If the bladder be distended half-way up to the umbilicus, which is commonly the case when it has to be tapped, we find that the bottom of the pouch would be about two inches from the symphysis pubis (fig. 87). Within this distance from the symphysis, the bladder may be tapped in the linea alba, without risk of wounding the peritoneum. Thus, the surgeon has the choice of two situations in which he may tap the bladder —above the pubes, or from the rectum. Which of the two be the more appropriate, must be decided by the circumstances of the case.

DISSECTION OF THE MALE PERINEUM.

Before dissecting the perineum, it is expedient first to examine the osseous and ligamentous boundaries of the lower aperture of the pelvis. Looking at the male pelvis (with the ligaments preserved), we observe that this aperture is of a lozenge shape; that it is bounded in front by the symphysis of the pubes, laterally by the rami of the pubes and ischium; behind, by the coccyx and the great sacro-ischiatic ligaments.

Fig. 88.

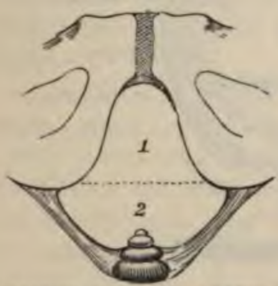


DIAGRAM OF THE FRAMEWORK OF THE PERINEUM.

This space, for convenience of description, is divided into two by a line drawn from one tuber ischii to the other. The anterior forms a nearly equilateral triangle, of which the sides are from three to three and a-half inches long; and since it transmits the urethra, it is called the *urethral division* of the perineum. The posterior, containing the anus, is called the *anal division* (fig. 88, 2).*

The subject should be placed in the usual position for lithotomy, with a full-sized staff in the bladder, the rectum moderately distended with tow, and the scrotum raised by means of hooks. A

* The dimensions of the lower outlet of the pelvis are apt to vary in different subjects, and the lithotomist must modify his incisions accordingly.

central ridge, named the *raphé*, extends from the anus, along the perineum, scrotum, and under surface of the penis. Between the tuberosities of the ischia and the anus are two depressions, one on each side, marking the *ischio-rectal fossæ*, which are found immediately beneath the skin, filled with more or less fat. In the lateral operation of lithotomy, the incision should commence at a point midway between the anus and the posterior fold of the scrotum, close to the left side of the raphé; it should be carried downwards and outwards to a point midway between the tuber ischii and the anus. In the bilateral operation, the incision is semi-lunar, the horns being made on either side between the tuber ischii and the anus, equidistant from these points respectively; while the centre of the incision runs about three-quarters of an inch above the anus.

ANAL GLANDS. At the anus the skin becomes finer and more delicate, forming a gradual transition towards mucous membrane: during life it is drawn into wrinkles by the permanent contraction of the cutaneous sphincter. Moreover, the skin at the margin of the anus is provided with numerous minute glands,* which secrete an unctuous substance to facilitate the passage of the fæces. When this secretion becomes defective or vitiated, the anal cutaneous folds are apt to become excoriated, chapped, or fissured; and then defæcation becomes very painful.

DISSECTION. The skin should be reflected, by making an incision along the raphé, round the margin of the anus to the coccyx. Two others must be made on each side at right angles to the first, the one at the upper, and the other at the lower end of it. The skin of the perineum must then be reflected outwards. In reflecting the skin, notice the charac-

SUBCUTANEOUS TISSUE. ters of the subcutaneous structure.† Its characters

* These glands are the analogues of the anal glands in some animals, e.g. the dog and the beaver. They are found not only about the anus, but also in the subcutaneous tissue of the perineum, a fact for the demonstration of which we are indebted to the late Professor Quekett. They are large enough to be seen with the naked eye.

† The probable thickness of this subcutaneous tissue is a point which ought to be determined by the lithotomist in making his first incision. Its great thickness in some cases explains the depth to which the surgeon has to cut in letting out pus from the ischio-rectal fossa.

alter in adaptation to the exigencies of each part. On the scrotum the fat constituent of the tissue is entirely absent; while the connective tissue element is most abundant, and during life elastic and contractile. But, towards the deeper part of the anus,

FAT IN ISCHIO-RECTAL FOSSÆ.

the fat accumulates more and more, and on either side of the rectum it is found in the shape of large masses, filling up what would otherwise be two deep hollows in this situation—namely, the *ischio-rectal fossæ*. These fossæ are triangular, with their bases towards the skin, and their apices at the divergence of the obturator internus and levator ani. They are about two inches in depth, and much deeper posteriorly than in front. This accumulation of fat on each side of the anus, permits the easy distension and contraction of the lower end of the bowel during and after the passage of the fæces. Over the tuberosities of the ischia are large masses of fat, separated by tough, fibrous septa, passing from the skin to the bone, so as to make an elastic padding to sit upon. Occasionally, too, there are one or more large *bursæ*, interposed between this padding and the bone.

So much respecting the general characters of the subcutaneous tissue of the perineum. Some anatomists describe it as consisting of three, four, or even more layers, but in nature we do not find it so. It may, indeed, be divided into as many layers as we please, according to our skill in dissection; but this only complicates what is, in itself, simple.

DISSECTION.

The external sphincter ani must now be cleaned; care being taken not to remove any of its fibres; which are intimately connected with the skin. Posteriorly, the lower border of the gluteus maximus must be displayed, and the vessels and nerves crossing the perineum, towards the anus, carefully dissected.

EXTERNAL SPHINCTER ANI.

The external sphincter of the anus is elliptical, and *arises* from the point of the coccyx, and the ano-coccygeal ligament. The muscular fibres surround the anus, and are *inserted* in a pointed manner in the tendinous centre of the perineum (p. 419). It is called the external sphincter, to

distinguish it from a deeper and more powerful band of muscular fibres which surrounds the last inch or more of the rectum, and is situated next to the mucous membrane.

CUTANEOUS VESSELS AND NERVES. The cutaneous vessels and nerves of the perineum come from the internal pudic artery and nerve, and chiefly from that branch of it called the *superficialis perinei.* This will be traced presently.

The *external* or *inferior hæmorrhoidal arteries*, cross transversely through the ischio-rectal fossa, from the ramus of the ischium towards the anus. They come from the pudic (which may be felt on the inner side of the ischium), and running inwards, divide into numerous branches, which supply the rectum, levator ani, and sphincter ani. The *nerve* which accompanies the artery comes from the pudic, and supplies the sphincter ani and the skin of the perineum.

The *fourth sacral nerve* emerges through the coccygeus close to the tip of the coccyx, and supplies the skin of the perineum between this bone and the anus.

The *inferior pudendal nerve* comes through the muscular fascia of the thigh, a little above the tuber ischii, and ascends, dividing into filaments, which supply the front and outer part of the scrotum and perineum. It is a branch of the lesser ischiatic nerve, and communicates in front with the posterior branch of the superficial perineal nerve.

SUPERFICIAL FASCIA OF THE PERINEUM. The subcutaneous fascia of the perineum is composed of a *superficial* and a *deep* layer. The *superficial* layer contains more or less fat, and is continuous with that of the scrotum, the thighs, and the posterior part of the perineum. The *deeper* layer is best demonstrated by blowing air beneath it with a blow-pipe; its connections are as follows:—It is attached on each side to the anterior lip of the ramus of the pubes and ischium; traced forwards, it is directly continuous with the *tunica dartos* of the scrotum; traced backwards, at the base of the urethral triangle, it is reflected beneath the transversus perinei muscle, and joins the *deep perineal fascia* or *triangular ligament.* These connections explain why urine,

effused into the perineum, does not make its way into the ischio-rectal fossæ, or down the thighs, but passes readily into the scrotum and penis.

DISSECTION. Remove the fascia to see the muscles which cover the bulb of the urethra and the crura of the penis. The bulb of the urethra lies in the middle of the perineum, and is covered by a strong muscle, called accelerator urinæ. The crura penis are attached, one to each side of the pubic arch, and are covered each by a muscle, called erector penis. A narrow slip of muscle, called transversus perinei, extends on either side from the tuber ischii to the *central tendinous point* of the perineum. This point is about one inch and a quarter in front of the anus, and serves for the attachment of muscular fibres from all quarters of the perineum.

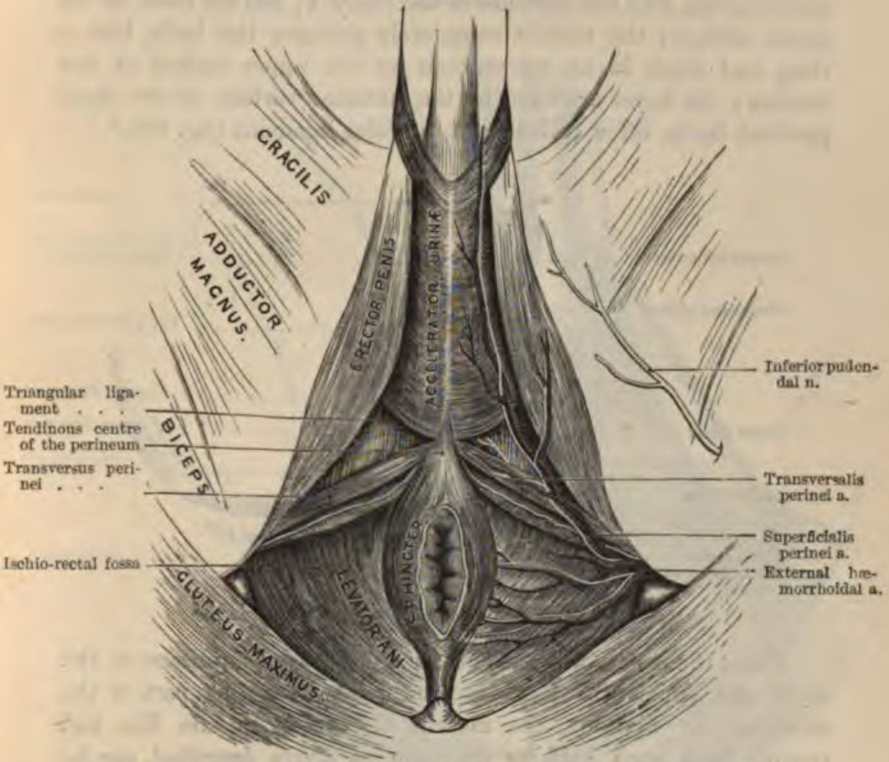
Thus the muscles of the perineum describe on each side a triangle, of which the sides are formed by the accelerator urinæ and the crus penis respectively, and the base by the transversus perinei. Across this triangle run up from base to apex the superficial perineal vessels and nerves. External to the ramus of the ischium is seen the *inferior pudendal* nerve, a branch of the lesser ischiatic.

SUPERFICIAL PERINEAL VESSELS AND NERVES. The *superficial perineal* artery comes from the internal pudic as it runs up the inner side of the tuber ischii. Though the main trunk cannot be seen, it can be easily felt by pressing the finger against the bone. The artery comes into view a little above the level of the anus, passes up the perineal triangle, distributing branches to all the muscles, and is finally lost on the scrotum. The only named branch is called *transversalis perinei* (fig. 89). This is given off near the base of the triangle, and runs with the transversus perinei muscle towards the central point of the perineum, where it anastomoses with its fellow. It is necessarily divided in the first incision in lithotomy, and deserves attention, because it is sometimes of considerable size.

The artery is accompanied by two *veins*, which are frequently dilated and tortuous, especially in diseased conditions of the scrotum.

The *nerves*, two in number, are derived from the internal pudic, follow the course of their corresponding arteries, and give off similar branches. They not only supply the skin of the perineum and scrotum, but each of the perineal muscles.

Fig. 89.



MUSCLES, WITH SUPERFICIAL VESSELS AND NERVES, OF THE PERINEUM.

The *inferior pudendal nerve*, a branch of the lesser ischiatic, makes its exit through the muscular fascia of the thigh, a little above the tuber ischii. It ascends nearly parallel to the ramus of the ischium and pubes, and dividing into filaments, supplies the skin of the front of the perineum and scrotum.

ACCELERATOR URINÆ. This muscle embraces the bulb of the urethra. It *arises* from a fibrous median raphé beneath the bulb, and from the tendinous centre of the perineum. Starting from this origin, the fibres diverge, and are *inserted* as follows:— The upper ones proceed on either side round the corpus cavernosum penis, like the branches of the letter V, and are fixed on its dorsal surface; the middle completely embrace the bulb, like a ring, and meet in an aponeurosis on the upper surface of the urethra; the lower are fixed to the anterior surface of the deep perineal fascia, often called the triangular ligament (fig. 90).*

FIG. 90.

DIAGRAM TO SHOW THE ACCELERATOR URINÆ IN PROFILE.

Thus, the entire muscle acts as a powerful compressor of the bulb, and expels the last drops of urine from this part of the urethra. By dividing the muscle along the middle line and turning back each half, its insertion, as above described, can be clearly made out.†

ERECTOR PENIS. This muscle is moulded upon the crus of the penis. It *arises* from the inner surface of the tuber ischii; the fibres ascend, completely covering the crus, and

* This muscle is called also the *ejaculator urinæ* or the *bulbo-cavrenosus.*

† According to Hobelt, the dorsal insertion of the upper fibres throws a prolongation over the dorsal vessels of the penis.

terminate on a strong aponeurosis, which is *inserted* into the external and inferior aspect of the crus. The *action* of this muscle is to compress the root of the penis, and so to contribute to the erection of the organ.*

FIG. 91.

Crus penis . . . . .
Crus penis with its artery cut through . .
Ramus of the pubes .
Artery of the bulb . .
Cowper's gland . . .
Pudic artery . . .
Tuber ischii . . . .

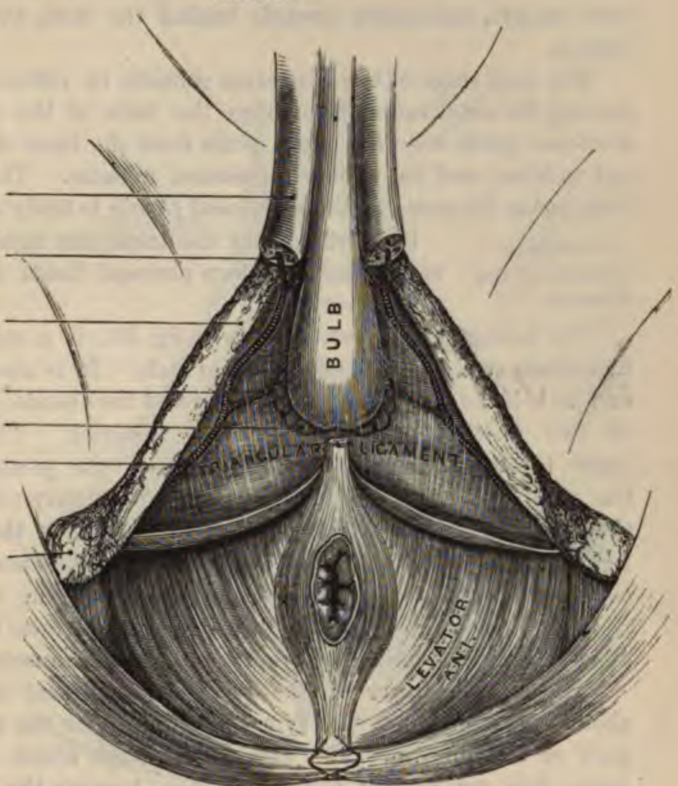


DIAGRAM TO SHOW THE TRIANGULAR LIGAMENT OF THE URETHRA OR DEEP PERINEAL FASCIA.

TRANSVERSUS PERINEI. This muscle is of insignificant size, and sometimes absent. It *arises* from the inner aspect of the tuber ischii, and proceeds forwards and inwards towards the

* This muscle is sometimes called the *ischio-cavernosus*.

central point of the perineum, where it is blended with the fibres of the accelerator urinæ. This muscle with its artery is divided in lithotomy.

The *deep transversus perinei* is a small muscle occasionally present; it arises more deeply from the pubic arch than the superficial muscle, and passes inwards behind the bulb, to the central tendon.

The next stage of the dissection consists in reflecting and removing the accelerator urinæ from the bulb of the urethra, the erectores penis with the crura penis from the rami of the pubes and ischium, and the transversi perinei muscles. This done, the *triangular ligament* or *deep perineal fascia* is fairly exposed.

TRIANGULAR LIGAMENT OF THE URETHRA. Understand that the triangular ligament of the urethra and the deep perineal fascia are synonymous terms.

The triangular ligament, shown in fig. 91, is a strong fibrous membrane stretched across the pubic arch. It is about an inch and a half long, with the base directed backwards. It consists of two layers, an anterior and a posterior. The *anterior layer* is firmly attached on each side to the *posterior* lip of the rami of the pubes and ischium; superiorly—*i.e.* towards the symphysis of the pubes—it is connected with the sub-pubic ligament; inferiorly, it does not present a free border, but is connected to the tendinous centre of the perineum, and is continuous with the deep layer of the superficial perineal fascia which curves backwards under the transversus perinei muscle (p. 417).

The anterior layer of the triangular ligament is perforated about one inch below the symphysis pubis, for the membranous part of the urethra. The aperture through which the urethra passes does not present a distinct edge, because the ligament is prolonged forwards over the bulb, and serves to keep it in position.

The *posterior layer* cannot at present be seen. It belongs, strictly speaking, to the pelvic fascia, and slopes somewhat backwards from the anterior layer so as to leave an interval between them in which are found structures which will be presently described.

POINTS OF SURGICAL INTEREST. The triangular ligament is very important surgically for these reasons :—

1. Here we meet with difficulty in introducing a catheter, unless we can hit off the right track through the ligament. The

FIG. 92.

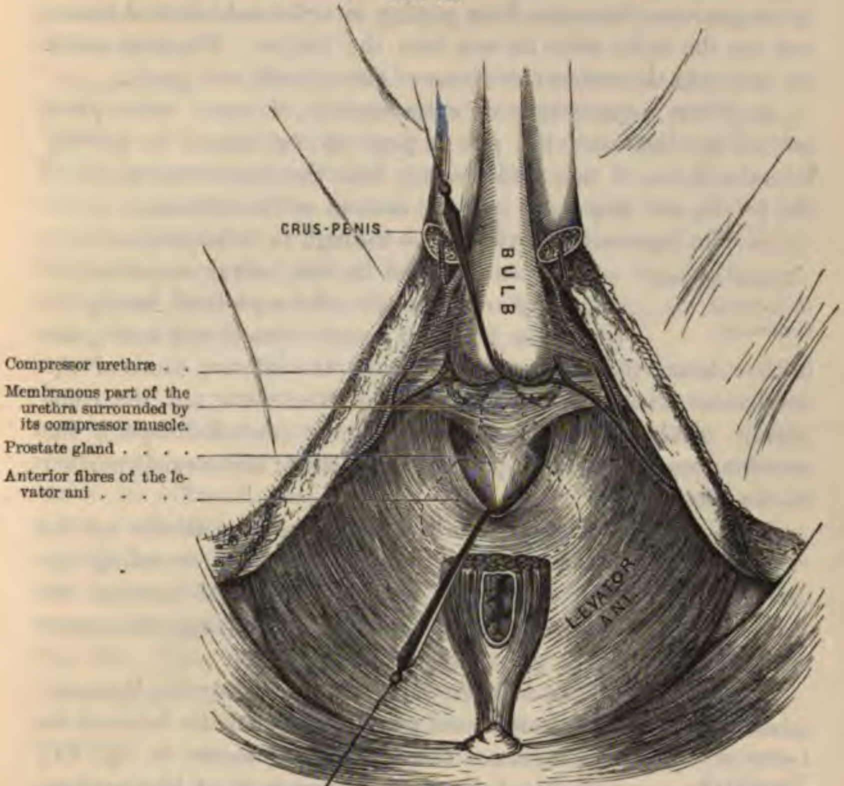


DIAGRAM OF THE PARTS BEHIND THE ANTERIOR LAYER OF THE TRIANGULAR LIGAMENT OF THE URETHRA.

(The anterior fibres of the levator ani are hooked down to show part of the prostate; the rest is tracked by a dotted line.)

soft and spongy tissue of the bulbous part of the urethra in front of the ligament readily gives way, if force be used, and a false passage results.

2. By elongating the penis, we are much more likely to hit off the proper opening through the ligament.

3. When, in retention of urine, the urethra gives way *anterior* to this ligament, it is this which prevents the urine from travelling into the pelvis. Its connection with the superficial perineal fascia prevents the urine from getting into the ischio-rectal fossæ: nor can the urine make its way into the thighs. The only outlet for it is into the connective tissue of the scrotum and penis.

4. When suppuration or extravasation of urine takes place *behind* the ligament, the pus is pent up and should be speedily let out; if not, it may find its way into the connective tissue of the pelvis, and may burst into the urethra or the rectum.

5. The ligament is partially cut through in lithotomy.

PARTS DIVIDED IN LATERAL LITHOTOMY.

The parts divided in the lateral operation of lithotomy are: the skin, the superficial fascia, the transverse perineal muscle vessels and nerve, the inferior hæmorrhoidal vessels and nerves, the inferior fibres of the accelerator urinæ, the anterior fibres of the levator ani, the compressor urethræ, the triangular ligament (anterior layer), the membranous and prostatic parts of the urethra, and a small portion of the prostate.

PARTS TO BE AVOIDED.

The incision in lateral lithotomy should not be made too far forwards, for fear of wounding the artery of the bulb; nor too far inwards, for fear of injuring the rectum; nor too far outwards, for fear of cutting the pudic artery.

STRUCTURES BETWEEN THE LAYERS OF THE TRIANGULAR LIGAMENT.

The anterior layer of the triangular ligament must now be cut away to see what lies between its two layers. These parts are shown in fig. 92; namely: 1, the membranous part of the urethra, surrounded by, 2, the compressor urethræ muscle; 3, Cowper's glands; 4, the pudic artery and its three terminal branches, i.e. the artery of the bulb, the artery of the crus, and the dorsal artery of the penis; 5, the pudic nerve and its branches.

DISSECTION.

To obtain the best perineal view of the compressor urethræ muscle, cut through the spongy

part of the urethra about three inches above the end of the bulb, and dissect it from the corpus cavernosum. Thus, the upper fibres of the constrictor will be exposed ; to see the lower, it is only necessary to raise the bulb. The most perfect view, however, of the muscle is obtained by making a transverse section through the rami of the pubes, so as to get at the muscle from above, as shown in fig. 93.

COMPRESSOR OR CONSTRICTOR URETHRÆ. This muscle consists of transverse fibres which surround and support the urethra in its passage beneath the pubic arch. It *arises* from the ramus of the pubes on either side; from thence its fibres pass, some above, some below the urethra, along the whole length of its membranous part. It forms a complete muscular covering for the urethra between the prostate and the bulb. It is chiefly through its agency that we retain the urine. This muscle is the chief cause of spasmodic stricture of the urethra.*

COWPER'S GLANDS. These small glands are situated, one on either side, immediately behind the bulb between the two layers of the triangular ligament, in the substance of the compressor urethræ. Their size is about that of a pea, but it varies in different individuals. They are compound racemose glands, consisting of several lobules firmly connected together by cellular and some muscular tissue. From each a slender duct runs forwards, and, after a course of about one inch, opens obliquely into the floor of the bulbous part of the urethra (fig. 90). They furnish a secretion accessory to generation.

PUDIC ARTERY AND ITS BRANCHES. The *pudic artery* is a branch of the anterior division of the internal iliac. It leaves the pelvis through the great ischiatic notch, above the ischiatic artery, winds round the spine of the ischium, re-enters the pelvis through the lesser ischiatic notch, and then runs along the inner side of the tuber ischii, between the layers of the obturator fascia, up towards the pubic arch. About an inch and a half above the

* The compressor urethræ was first accurately described and delineated by Santorini (septemdec. tabulæ), and afterwards by Müller in his monograph (Ueber die organ. Nerv. der männlich. Geschlechtsorgane).

tuber ischii, the trunk of the pudic artery can be felt; but we cannot see it, nor draw it out, for it is securely lodged in a fibrous canal formed by the obturator fascia. In the present dissection

Fig. 93.

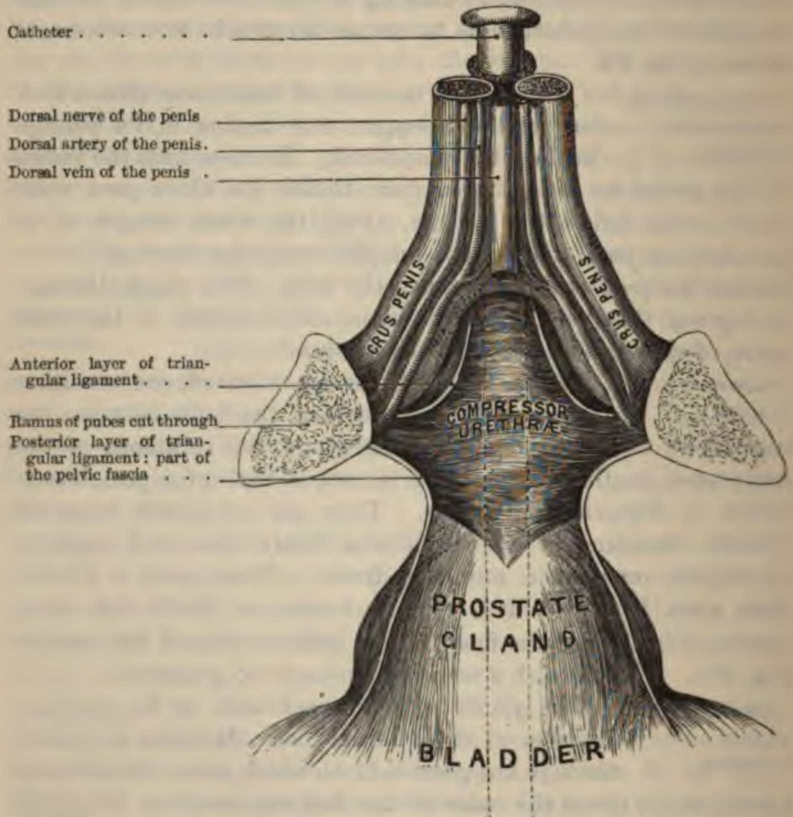


DIAGRAM OF THE RELATIONS OF THE COMPRESSOR URETHRÆ SEEN FROM ABOVE.

we find the artery between the two layers of the triangular ligament, where it gives off its three chief branches, namely, the artery of the bulb of the urethra, the artery of the crus penis, and the dorsal artery of the penis (fig. 91).

Taken in order, the branches of the pudic artery are as follows:—

a. The *external hæmorrhoidal*, the *superficial perineal*, and the *transverse perineal* branches have already been described (pp. 417, 418).

b. The *artery of the bulb* is of considerable size, and passes transversely inwards; it runs through the substance of the compressor urethræ, and before it enters the bulb divides into two or three branches. It also sends a small branch to Cowper's gland. From the direction of this artery it will at once strike the attention that there is great risk of dividing it in lithotomy. If the artery run along its usual level, and the incision be not made too high in the perineum, then indeed it is out of the way of harm. But, supposing the reverse, the vessel must be divided. This deviation from the normal distribution is met with about once in twenty subjects, and there is no possibility of ascertaining this anomaly beforehand.

c. The *artery of the crus penis*, one of the terminal branches, ascends for a short distance near the pubic arch and soon enters the crus.

d. To see the *dorsal artery* of the penis, the penis should be dissected from its attachment to the symphysis pubis. The artery can be traced upon the dorsum of the penis down to the glans. It forms a complete arterial circle with its fellow round the corona glandis, and gives numerous ramifications to the papillæ on the surface.

The *veins* corresponding to the branches of the pudic artery terminate in the pudic vein, with the exception of the dorsal vein of the penis. This runs along the middle of the dorsum of the penis, and passing under the symphysis pubis opens into the prostatic plexus.

PUDIC NERVE. The pudic nerve comes from the sacral plexus, and corresponds both in its course and branches with the artery. It gives off its external or inferior hæmorrhoidal, and its superficial perineal branches—a small one to the bulb, and another to the crus penis; but the main trunk of the nerve runs with the artery along the dorsum of the penis to the glans (fig. 93). In its passage it supplies the integuments of the penis, and sends one or two branches into the corpus cavernosum. This part of the penis also receives nerves from the sympathetic system.

Ischio-rectal Fossa. This is the deep hollow, on each side, between the anus and the tuber ischii. When all the fat is removed from it, observe that it is lined on all sides by fascia. Introduce the finger into it to form a correct idea of its extent and boundaries. *Externally* it is bounded by the tuber ischii and the fascia covering the obturator internus muscle; *internally*, by the rectum, levator ani and coccygeus; *posteriorly*, by the gluteus maximus; *anteriorly*, by the transversus perinei. The fossa is crossed by the external hæmorrhoidal vessels and nerves.

These deep spaces on each side of the rectum explain the great size which abscesses in this situation may attain. The matter can be felt only through the rectum. Nothing can be seen outside. Perhaps nothing more than a little hardness can be felt by the side of the anus. These abscesses should be opened early; else they form a large cavity, and may burst into the rectum, and result in a fistula.

ANATOMY OF THE SIDE VIEW OF THE PELVIC VISCERA.

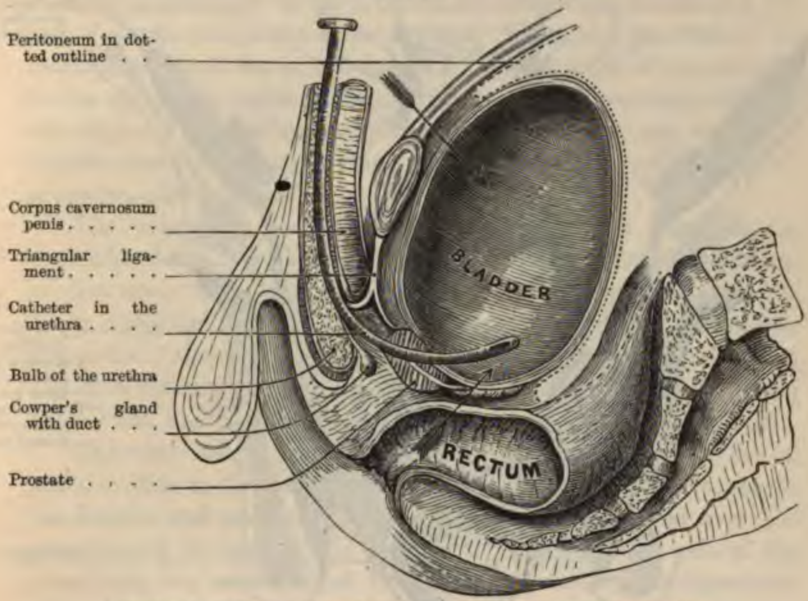
Dissection. To obtain a side view of the pelvic viscera, the left innominate bone should be removed thus:—Detach the peritoneum and the levator ani from the left side of the pelvis, cut through the external iliac vessels, the obturator vessels and nerve, and the nerves of the lumbar plexus; then saw through the pubes about two inches external to the symphysis, and cut through the sacro-iliac symphysis; now draw the legs apart, and saw through the base of the spine of the ischium; after cutting through the pyriformis, the great sacro-ischiatic ligament and ischiatic nerves, the innominate bone can be easily detached. This done, the rectum should be distended with tow, and the bladder blown up through the ureter. A staff should be passed through the urethra into the bladder, and a block placed under the sacrum.

The reflection of the peritoneum as it passes from the front of the rectum to the lower part of the bladder (forming the recto-vesical pouch), and thence over the back of the bladder to the wall

of the abdomen, has been already described. You see where the distended bladder is bare of peritoneum, and that it can be tapped either through the rectum or above the pubes without injury to the serous membrane, as shown by the arrows in fig. 94.

False Ligaments of the Bladder. The peritoneal connections of the bladder are called its false ligaments; *false* in contradistinction to the *true*, which are formed by the fascia of

Fig. 94.



VERTICAL SECTION THROUGH THE PERINEUM AND PELVIC VISCERA.

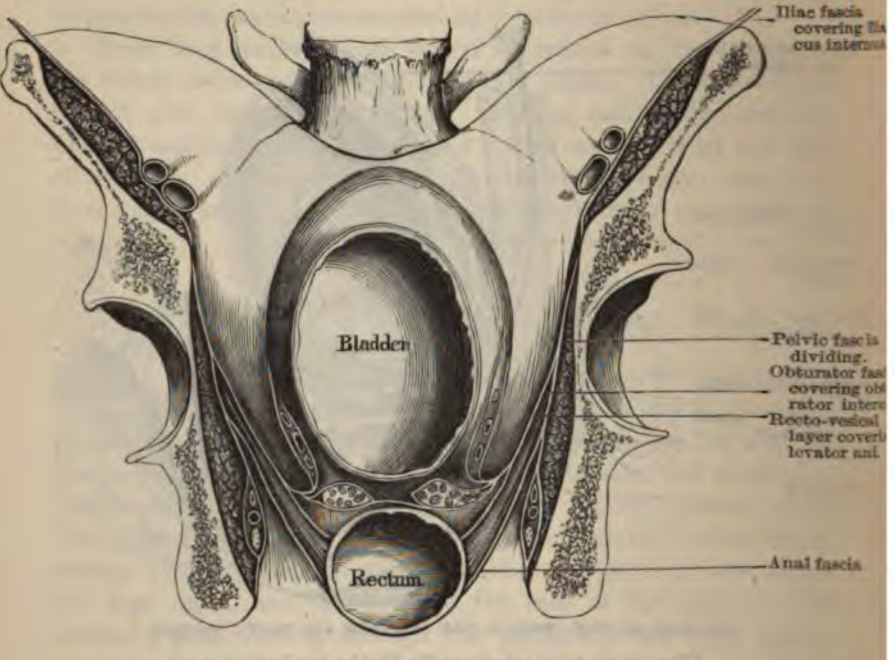
(The arrows point out where the bladder can be tapped.)

the pelvis, and really *do* sustain the neck of the bladder in its proper position. The false ligaments are five in number, two posterior, two lateral, and one superior. The *posterior* are produced by two peritoneal folds, one on either side the recto-vesical pouch; the *two lateral*, by reflections of the peritoneum from the sides of the pelvis to the sides of the bladder; the *superior* is produced by

the passage of the peritoneum from the front of the bladder to the abdominal wall.

PELVIC FASCIA. To expose the *pelvic fascia*, the peritoneum must be removed from that side of the pelvis which has not been disturbed: in doing so, notice the abundance of loose connective tissue interposed between the peritoneum and

FIG. 95.



TRANSVERSE SECTION OF THE PELVIS, TO SHOW THE REFLECTIONS OF THE PELVIC FASCIA. (*After Gray.*)

the fascia, to allow the bladder to distend with facility. Whenever urine is extravasted into this loose tissue, it is sure to produce the most serious consequences; therefore in all operations on the perineum, it is of the utmost importance not to injure this fascia.

The pelvic fascia is a thin but strong membrane, and constitutes the true ligaments of the bladder, and the other pelvic viscera, supporting and maintaining them in their proper position.

Examine, first, to what parts of the pelvis the fascia is attached; secondly, the manner in which it is reflected on the viscera.

Beginning, then, in front (fig. 95), the fascia is attached superiorly to the body of the pubes, to the side of the pelvis just above the obturator foramen, and to the greater ischiatic notch. Here it becomes gradually thinner, covers the pyriformis muscle and the sacral plexus, and is lost on the sacrum. From this attachment the fascia descends as far as a line drawn from the spine of the ischium to the symphysis pubis. Along this line, which corresponds with the origin of a considerable portion of the levator ani, the fascia divides into two layers, an inner, called the *recto-vesical fascia*; an outer, called the *obturator fascia.*

The *obturator fascia*, the outer layer of the pelvic fascia, descends on the inner surface of the obturator internus, forming, at the same time, a sheath for the pudic vessels and nerve, the nerve being the lowest. It is attached to the arch of the pubes, and to the tuberosities of the ischia. From this fascia is derived the *anal fascia*, which lines the under or perineal surface of the levator ani, and is subsequently lost upon the side of the rectum.

The *recto-vesical fascia* is the continuation of the pelvic fascia, and descends on the upper or internal surface of the levator ani to the bladder and prostate. From the pubes it is reflected over the prostate and the neck of the bladder, to form, on either side of the symphysis, two well-marked bands—the *anterior true ligaments* of the bladder. From the side of the pelvis it is reflected on to the side of the bladder, constituting the *lateral true ligaments* of the bladder, and incloses the prostate and the vesical plexus of veins. A prolongation from this ligament incloses the vesicula seminalis, and then passes between the bladder and the rectum, to join its fellow from the opposite side.

General Position of the Pelvic Viscera in the Male.

The pelvic viscera are so surrounded by veins and loose areolar tissue, that he who dissects them for the first time will find a difficulty in discovering

their definite boundaries. The rectum runs at the back of the pelvis, and follows the anterior curve of the sacrum and coccyx. The bladder lies in front of the rectum, immediately behind the symphysis pubis. At the neck of the bladder is the prostate gland through which the urethra passes. In the cellular tissue, between the bladder and the rectum, there is, on each side, a convoluted tube, called the vesicula seminalis, and on the inner side of each vesicula is the seminal duct or vas deferens. Before describing these parts in detail, it is necessary to say a few words about the large tortuous veins which surround them.

PLEXUS OF VEINS ABOUT PROSTATE AND NECK OF BLADDER.

Beneath the pelvic fascia surrounding the prostate and the neck of the bladder are large and tortuous veins, which form the prostatic and the vesical plexuses. They empty themselves into the internal iliac. In early life they are not much developed, but as puberty approaches they gradually increase in size, and one not familiar with the anatomy of these parts would hardly credit the size which they sometimes attain in old persons. They communicate freely with the inferior hæmorrhoidal plexus, or veins about the anus, and they receive the blood returning from the penis through the large veins which pass under the pubic arch.

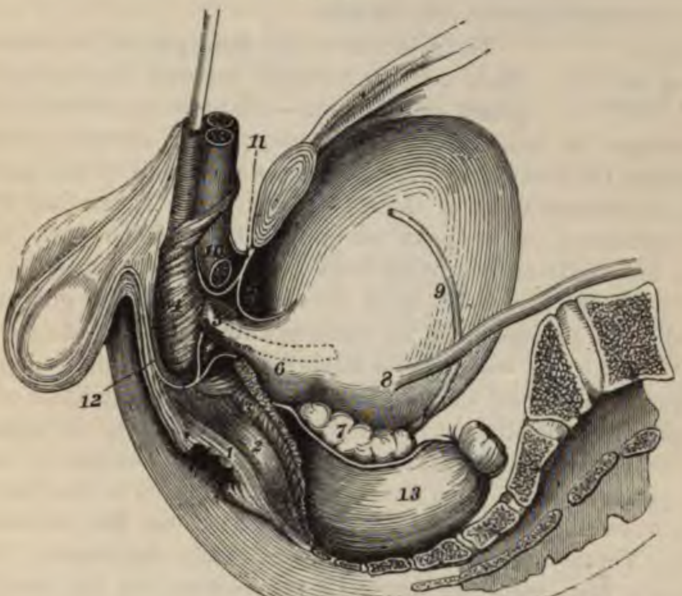
If, in lithotomy, the incision be carried beyond the limits of the prostate, the great veins around it must necessarily be divided; these, independently of any artery, are quite sufficient to occasion serious hæmorrhage.

RECTUM AND ITS RELATIONS.

The intestinum rectum is about eight inches long. It is a continuation of the sigmoid flexure of the colon, enters the pelvis at the left sacro-iliac articulation, describes a curve corresponding to the sacrum, and terminates at the anus. Before its termination, the bowel turns downwards so that the anal aperture is dependent. The rectum also inclines from the left side to the middle line, and, although it loses the sacculated appearance, is not throughout of equal calibre. Its capacity becomes greater as it descends into the pelvis; and, immediately above the sphincter, it presents a considerable dila-

tation (fig. 94). This dilatation is not material in early life, but it increases as age advances. Under such circumstances the rectum loses altogether its cylindrical form, and bulges up on either side of the prostate and the base of the bladder. For this reason the rectum should always be emptied before the operation of lithotomy.

Fig. 96.



SIDE VIEW OF THE PELVIC VISCERA.

(Taken from a Photograph.)

1. External sphincter.
2. Internal sphincter.
3. Levator ani cut through.
4. Accelerator urinæ.
5. Membranous part of the urethra, surrounded by compressor muscle.
6. Prostate gland.
7. Vesicula seminalis.
8. Ureter.
9. Vas deferens.
10. Crus penis divided.
11. Triangular ligament.
12. Superficial perineal fascia.
13. Rectum.

The upper part of the rectum (for about three inches and a half) is connected to the sacrum by a fold of peritoneum termed

meso-rectum. In this fold, the terminal branch of the inferior mesenteric artery with its vein runs up to supply the bowel. Below the meso-rectum, the intestine is connected posteriorly to the sacrum and coccyx by loose connective tissue, and is covered by peritoneum in front, which forms the recto-vesical pouch. The lower three inches and a-half are entirely destitute of peritoneum. The rectum is supported by the levatores ani, the larger portions of which are inserted into its side.

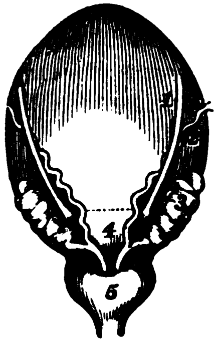
DIGITAL EXAMINATION OF THE RECTUM. The relations of the front part of the rectum—that, namely, included between the recto-vesical pouch and the anus—are most important. If the forefinger be introduced into the anus, and a catheter into the urethra, the first thing felt through the front wall of the bowel is the membranous part of the urethra (fig. 94). It lies just within the sphincter, and is about ten lines in front of the gut. About one and a half or two inches from the anus the finger comes upon the prostate gland; this is in close contact with the gut, and is readily felt on account of its hardness; by moving the finger from side to side we recognise its lateral lobes. Still higher up, the finger goes beyond the prostate, and reaches the trigone of the bladder: the facility with which this can be examined depends, not only upon the length of the finger and the amount of fat in the perineum, but upon the degree of distension of the bladder; the more distended the bladder, the better can the prostate be felt. These several relations are practically important. They explain why, with the finger in the rectum, we can ascertain whether the catheter is taking the right direction—whether the prostate be enlarged or not. We might even raise a stone from the bottom of the bladder so as to bring it in contact with the forceps.

The rectum is supplied with blood by the superior, middle, and inferior hæmorrhoidal arteries. The superior comes from the inferior mesenteric (p. 392); the middle and inferior from the pudic artery. The superior and middle hæmorrhoidal veins join the inferior mesenteric, and consequently the portal system; the inferior hæmorrhoidal veins join the internal pudic. They are

very large and form loop-like plexuses about the lower part of the rectum. Having no valves, they are liable to become dilated and congested from various internal causes; hence the frequency of hæmorrhoidal affections.

BLADDER. This viscus, being a receptacle for the urine, must necessarily vary in size, and accordingly the nature of its connections and coats are such as to permit this variation. When contracted, the bladder sinks into the pelvis behind the pubic arch, and is completely protected from injury. But, as it gradually distends, it rises out of the pelvis into the abdomen, and, in cases of extreme distension, may reach nearly up

FIG. 97.



POSTERIOR VIEW OF THE BLADDER.

to the umbilicus.* Its outline can then be easily felt through the walls of the abdomen. The form † of the distended bladder is

* When the bladder is completely paralysed it becomes like an inorganic sac, and there seems to be no limit to its distension. Haller found, in a drunkard, the bladder so dilated that it would hold twenty pints of water. ('Elem. Phys. art. Vesica.') Frank saw a bladder so distended as to resemble ascites, and evacuated from it twelve pounds of urine. (Oratio de Signis morborum, &c. &c. Ticini, 1788.)

W. Hunter, in his 'Anatomy of the Gravid Uterus,' has given the representation of a bladder distended nearly as high as the ensiform cartilage.

† In all animals with a bladder, the younger the animal the more elongated is the bladder. This is indicative of its original derivation from a tube, i.e. the *urachus*. In the infant, the bladder is of a pyriform shape, as it is, permanently, in the quadruped; but as we assume more and more the perpendicular attitude, the weight of the urine gradually makes the lower part more capacious.

oval, and its long axis, if produced, would pass superiorly through the umbilicus, and inferiorly through the end of the coccyx. The axis of a child's bladder is more vertical than that of the adult; for in children, the bladder is not a pelvic viscus. This makes lithotomy in them so much more difficult.

The quantity of urine which the bladder will hold without much inconvenience varies. As a general rule, it may be stated at about a pint. Much depends upon the habits of the individual; but some persons have, naturally, a very small bladder, and are obliged to empty it more frequently.

In young persons the lowest part of the bladder is the neck, or that part which joins the prostate. But as age advances, the bottom of the bladder gradually deepens so as to form a pouch behind the prostate. In old subjects, particularly if the prostate be enlarged, this pouch becomes deep, micturition becomes tedious, and the bladder cannot completely empty its contents. It sometimes happens that a stone in the bladder is not felt; the reason of which may be that the stone, lodged in such a pouch below the level of the neck of the bladder, escapes the detection of the sound. Under these circumstances, if the patient be placed on an inclined plane with the pelvis higher than the shoulders, the stone falls out of the pouch, and is easily struck.

URETER. This tube is about seventeen inches long, and conveys the urine from the kidney to the bladder. In the dissection of the abdomen (p. 394), it was seen descending along the psoas muscle, behind the spermatic vessels, and crossing the common iliac artery into the pelvis. Tracing it downwards, in the posterior false ligament of the bladder, we find that it runs along the side of the bladder; external to the vas deferens, and enters it about an inch and a half behind the prostate, and about two inches from its fellow of the opposite side (fig. 97). It perforates the bladder very obliquely, so that the aperture, being valvular, allows the urine to flow into, but not out of it. The narrowest part of the ureter is at the vesical orifice; here, therefore, a calculus is more likely to be arrested in its progress than at any other part of the canal.

VAS DEFERENS. This tube, about twenty-four inches in length, conveys the seminal fluid from the testicle into the prostatic part of the urethra. It ascends at the back part of the spermatic cord through the inguinal canal into the abdomen; then, leaving the cord at the inner ring, it curves round the epigastric artery, then crosses over the external iliac vessels, and descends into the pelvis on the side of the bladder, gradually approaching nearer the middle line. Before it reaches the prostate it passes between the bladder and the ureter; then, becoming very tortuous, it runs internal to the vesicula seminalis, and is joined by the duct of this vesicle. The common duct thus formed, *ductus communis ejaculatorius*, terminates in the lower part of the prostatic portion of the urethra (fig. 97, p. 435). In point of size and hardness, the vas deferens has very much the feel of whipcord.*

VESICULÆ SEMINALES. These are situated, one on either side, between the bladder and the rectum (fig. 96). Each is a tube, but so convoluted that it is like a little sacculated bladder. When rolled up, the tube is about two and a half inches long; unrolled, it would be more than twice that length, and about the size of a small writing quill. Several cæcal prolongations proceed from the main tube, after the manner of a stag's horn. The vesiculæ seminales do not run parallel, but diverge from each other, posteriorly, as far as the reflection of the recto-vesical peritoneal pouch, like the branches of the letter V; and each lies immediately on the outer side of the vas deferens, into which it opens. The vesiculæ seminales probably serve as reservoirs for the semen.

They contain a brownish-coloured fluid, presumed to be in some way accessory to the function of generation.†

* The description in the text assumes the bladder to be distended. But when the bladder is empty the vas deferens runs down upon the side of the pelvis. In this course it may be seen, through the peritoneum, crossing—1, the external iliac vessels; 2, the remains of the umbilical artery; 3, the obturator artery and nerve; 4, the ureter.

† The vesiculæ seminales are imperfectly developed till the age of puberty. In a child of three years of age they can hardly be inflated with the blowpipe.

PROSTATE GLAND.

The prostate gland is situated at the neck of the bladder, and surrounds the first part of the urethra (fig. 96). In the healthy adult it is about the size and shape of a chestnut. Its apex is directed forwards. It is surrounded by a plexus of veins (p. 432), and is maintained in its position by the pelvic fascia (p. 431). Its upper surface is about three-quarters of an inch below the symphysis pubis: its apex is about one inch and a half from the anus; the base is about two and a half.

Above the prostate are the anterior ligaments of the bladder, with the dorsal vein of the penis between them; *below*, and in contact with it, is the rectum; on *each side* of it is the levator ani; in *front* of it are the membranous part of the urethra (surrounded by its compressor muscle), and the triangular ligament; *behind*, are the neck of the bladder and the vesiculæ seminales with the ejaculatory ducts.

The transverse diameter is about one inch and a half; the vertical is about half an inch less. But the gland varies in size at different periods of life. In the child it is imperfectly developed: it gradually grows towards puberty, and generally increases in size with advancing age.

To ascertain the size and condition of the prostate during life, the bladder should be at least half full: the prostate is then pressed down towards the rectum, and readily within reach of the finger.

ANATOMY OF THE URETHRA IN ITS PASSAGE UNDER THE PUBIC ARCH.

The urethra is a canal about eight inches in length, and leads from the bladder to the end of the penis. It is divided into three portions—the *prostatic*, the *membranous*, and the *spongy*. At present only the relations of the *membranous part*, which comprises that part of the canal between the prostate and the bulb, can be examined. The urethra in this part is nearly one inch in length, but longer on its upper than its lower surface, in consequence of the encroachment of the bulb. In its passage under the arch of the pubes, it is surrounded by the compressor urethræ, and below it are Cowper's

glands. It traverses the two layers of the triangular ligament, and is about an inch below the symphysis pubis, and nearly the same distance from the rectum; it is not, however, equidistant from this portion of the intestine at all points, because of the downward bend which the rectum makes towards the anus.*

The membranous part of the urethra in children is very long, owing to the smallness of the prostate at that period of life; it is also composed of thin and delicate walls, and lies close to the rectum. In sounding a child, therefore, it is very necessary not to use violence, else the instrument is likely to pass through the coats of the urethra and make a false passage.

LEVATOR ANI. This muscle supports the anus and lower part of the rectum like a sling; and, with the coccygeus and compressor urethræ, forms a muscular floor for the cavity of the pelvis. To see the muscle, the pelvic fascia must be reflected from its upper surface. It *arises* from the posterior aspect of the pubes near the symphysis, from the spine of the ischium, and, between these bones, from the tendinous line which marks the division of the pelvic fascia into the obturator and recto-vesical layers (p. 430). From this long origin the fibres descend inwards, and are *inserted* thus—the anterior, passing under the prostate, meet their fellow in the middle line of the perineum in *front* of the anus (forming the 'so-called' levator prostatæ); the middle are inserted into the side of the rectum, while the posterior meet their fellow beneath the rectum.

The levator ani is supplied by the inferior hæmorrhoidal, the two lower sacral, and the coccygeal nerves.

The action of the levatores ani is to retract the anus and the rectum after it has been protruded in defæcation by the combined action of the abdominal muscles and the diaphragm.

COCCYGEUS. This muscle should be regarded as a continuation of the levator ani. It *arises* by its apex from the spine of the ischium, gradually spreads out, and is *in-*

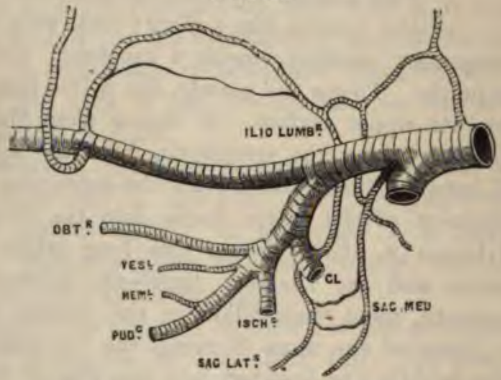
* If a clean vertical section were made, we should see that the two canals form the sides of a triangular space, of which the apex is towards the prostate. This is sometimes called the recto-urethral triangle.

serted into the side of the sacrum and the coccyx. This muscle is supplied by the two lower sacral and the coccygeal nerves.

DISSECTION. At this stage of the dissection, the bladder should be drawn downwards, and the branches of the internal iliac artery and the sacral plexus clearly displayed.

INTERNAL ILIAC ARTERY AND BRANCHES. From the division of the common iliac artery, the *internal iliac* descends into the pelvis, and, after a course of about an inch and a half, divides, opposite the great sacro-ischiatic notch, into two large branches, an anterior and a posterior (fig. 98). The artery lies upon the

FIG. 98.



PLAN OF THE BRANCHES OF THE INTERNAL ILIAC.

lumbo-sacral cord, the pyriformis muscle, the external and internal iliac veins; the ureter, enclosed in the posterior false ligament of the bladder, passing in front.

The *posterior* division gives off the ilio-lumbar, lateral sacral, and gluteal arteries; the *anterior* gives off the superior vesical, obturator, inferior vesical, middle hæmorrhoidal, ischiatic and pudic; also the uterine and vaginal in the female. Such is their usual order; but these branches, though constant as to their general distribution, vary as to their origin.

The branches of the posterior division are—

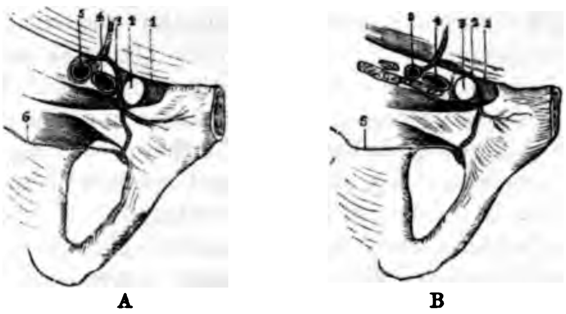
a. The *ilio-lumbar* is analogous to the lumbar branches of the

aorta. It ascends beneath the psoas, sends branches to this muscle and the quadratus lumborum; then running near the crest of the ilium, it supplies the iliacus internus, and finally inosculates with the deep circumflexa ilii (fig. 98).

b. The *lateral sacral*, usually two in number, descend in front of the sacral foramina, and inosculate on the coccyx with the middle sacral artery. They give branches to the pyriformis, the bladder, and rectum, and others which enter the anterior sacral foramina for the supply of the cauda equina.

c. The *gluteal* is the largest branch. It passes immediately out of the pelvis through the great ischiatic notch, above the pyriformis muscle, and then divides into branches for the supply of the great muscles of the buttock. These will be dissected with the thigh.

FIG. 99.



VIEW OF THE DIFFERENT DIRECTIONS WHICH AN ABNORMAL OBDURATOR ARTERY MAY TAKE. (*Seen from above.*)

A. 1. Gimbernat's ligament.
2. Femoral ring.
3. Abnormal obturator artery.
4. External iliac vein.
5. External iliac artery.
6. Diminutive obturator artery arising from its normal source.

B. 1. Gimbernat's ligament.
2. Abnormal obturator artery.
3. Femoral ring.
4. External iliac vein.
5. External iliac artery.
6. Diminutive obturator artery.

The anterior division gives off—

a. The *superior vesical* artery comes off from the unobliterated portion of the hypogastric, and supplies the upper part of the

bladder. It gives off the *middle vesical* artery; and a still smaller one, the *deferential*, which accompanies the vas deferens.

b. The *inferior vesical* artery ramifies on the under surface of the bladder, the vesiculæ seminales and the prostate, and gives off the *middle hæmorrhoidal* which supplies the rectum.

c. The *obturator* artery runs along the side of the pelvis, below the corresponding nerve, to the upper part of the obturator foramen, through which it passes to be distributed to the muscles of the thigh. In the pelvis it lies between the peritoneum and the pelvic fascia, and gives off a small branch to the iliacus internus, and another, the *pubic*, which ramifies on the back of the pubes.

The obturator artery does not, in all subjects, take the course above stated. It may arise from the external iliac near the crural arch, or by a short trunk in common with the epigastric.* Under these circumstances, in order to reach the obturator foramen, it generally descends on the *outer* side of the femoral ring. Instances however, occasionally occur, where it makes a sweep round the *inner* side of the ring; so that three-fourths of the ring, or, what comes to the same thing, of the neck of a femoral hernia, would in such a case be surrounded by a large artery.†

d. The *ischiatic* artery is smaller than the gluteal. It proceeds over the pyriformis and the sacral plexus, to the lower border of the great ischiatic notch, through which it passes out of the pelvis to the buttock, where it runs with the great ischiatic nerve. It gives off small muscular branches in the pelvis to the pyriformis and coccygeus.

e. The *pudic* artery supplies the perineum, scrotum and penis. In the pelvis it usually lies above the ischiatic, and rests upon the

* In most subjects a small branch of the obturator ascends behind the ramus of the pubes to inosculate with the epigastric. The variety in which the obturator arises in common with the epigastric is but an unusual development of this branch. The branch derives additional interest from the fact, that after ligature of the external iliac it becomes greatly enlarged, and carries blood directly into the epigastric. See a case in 'Med. Chir. Trans.' vol. xx. 1836.

† The Museum of St. Bartholomew's Hospital contains two examples of double femoral herniæ in the male, with the obturator arising on each side from the epigastric. In three out of the four ruptures the obturator runs on the inner side of the mouth of the sac. (See Preparations 55, 69, Series 17.)

pyriformis and sacral plexus, having the rectum to its inner side. It passes out of the pelvis through the great ischiatic notch, below the pyriformis, crosses the spine of the ischium, and re-enters the pelvis through the lesser notch. It then ascends on the inner side of the obturator internus towards the pubic arch, where it gives branches to the several parts of the penis. In its passage on the inner side of the obturator muscle it is enclosed in a strong tube of fascia (formed by the obturator fascia), and is situated about one inch and a quarter above the tuberosity of the ischium. The branches of the pudic artery were described in the dissection of the perineum (p. 425).

The pudic artery, however, sometimes takes a very different course. Instead of passing out of the pelvis, it may run by the side of the prostate gland to its destination; or, one of the large branches of the pudic may take this unusual course, while the pudic itself is regular, but proportionably small. Anatomists are familiar with these varieties, and a winter session rarely passes without meeting with one or two examples of them. It need hardly be said that lithotomy, under such conditions, might be followed by a large hæmorrhage.

f. The *middle sacral artery* is a very diminutive prolongation of the aorta down to the coccyx. It becomes gradually smaller, and finally inosculates with the lateral sacral arteries. In animals this is the artery of the tail.

Respecting the *veins* in the pelvis, they correspond with the arteries, and empty themselves into the internal iliac vein. The remarkable plexus of veins about the prostate, neck of the bladder, and rectum, has been described (p. 432).

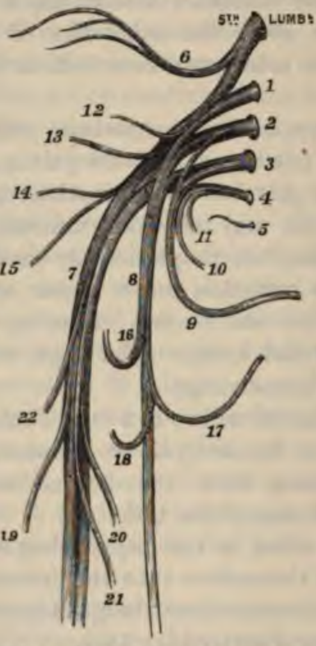
NERVES OF THE PELVIS. Those which proceed from the spinal cord should be examined first, afterwards those derived from the sympathetic system.

SACRAL NERVES. Five sacral nerves proceed from the spinal cord through the anterior sacral foramina. The upper four, from their large size, at once attract observation; but the fifth is small: it perforates the coccygeus muscle, supplying it and the skin over the coccyx.

The lower part of the *fourth sacral* nerve does not form part of the plexus; it gives off branches to the pelvic organs, and muscular twigs to the levator ani, coccygeus, and the external sphincter.

The *coccygeal* nerve, not easily found, pierces the great sacro-ischiatic ligament and coccygeus; it communicates with the fifth

Fig. 100.



12. N. of pyriformis.
13. N. of gemellus superior.
14. N. of gemellus inferior.
15. N. of quadratus femoris.
16. N. of gluteus maximus.
17. Long pudendal n.
18. Cutaneous n. of the buttock.
19. N. of the long head of the biceps.
20. N. of semi-tendinosus.
21. N. of semi-membranosus.
22. N. of short head of the biceps.

1, 2, 3, 4, 5. Sacral nn.
6. Superior gluteal n.
7. Great ischiatic n.
8. Lesser ischiatic n.
9. Pudic n.
10. N. of obturator internus.
11. N. of levator ani.

PLAN OF THE SACRAL PLEXUS AND BRANCHES.

sacral nerve, and supplies the same parts; namely, the coccygeus and the skin over the coccyx.

Sacral Plexus. The three upper sacral nerves, and part of the fourth, with the lumbo-sacral cord, form the sacral plexus. The great nerves of the plexus lie on the pyriformis muscle, beneath the branches of the internal iliac artery, and coalesce to form the great ischiatic nerve, which passes out at

the back of the pelvis, for the supply of the flexor muscles of the inferior extremity. The other branches of the plexus are as follows:—

a. Muscular branches distributed to the levator ani, the coccygeus, the external sphincter of the anus, the pyriformis, gemelli, quadratus femoris, and obturator internus. The nerve to the last-named muscle (sometimes derived from the pudic) leaves the pelvis with the pudic artery, and re-enters with it to reach the muscle. The branch to the inferior gemellus and quadratus femoris passes beneath those muscles and enters their anterior aspect. It also sends a filament to the hip-joint.

b. The *superior gluteal* nerve proceeds from the lumbo-sacral, leaves the pelvis above the pyriformis with the gluteal artery, and supplies the gluteus medius and minimus, and the tensor fasciæ femoris.

c. The *lesser ischiatic* supplies the gluteus maximus, the skin of the buttock, the perineum, and the back of the thigh.

d. The *pudic* nerve runs with the pudic artery, and like it, supplies the rectum, the muscles of the perineum, and the penis.

e. The *branches for the pelvic viscera* are very small. They proceed chiefly from the third and fourth sacral nerves, and form an intricate plexus about the bladder, prostate, and rectum.

SYMPATHETIC NERVE. From the lumbar region the sympathetic nerve descends into the pelvis, along the inner side of the sacral foramina. In this part of its course its ganglia vary in number from three to five. The nerves of opposite sides unite in front of the coccyx, where they form the *ganglion impar*.

The arrangement of the sympathetic nerves in the pelvis is similar to that in the abdomen. Each ganglion receives one or two filaments from a spinal nerve, and then gives off its branches to the viscera. The visceral branches are exceedingly delicate, and cannot be traced unless the parts have been previously hardened in spirit. They accompany the arteries supplying the respective organs, and are called the *vesical*, *prostatic*, and *inferior hæmorrhoidal plexuses*; and in the female the *uterine* and *vaginal*.

The vesical filaments of the sympathetic do not stop at the prostate, but pass on beneath the pubic arch into the corpus cavernosum penis. Thus the erectile tissue of the intromittent organ is brought directly within the influence of the sympathetic system.*

STRUCTURE OF THE BLADDER, PROSTATE, URETHRA, AND PENIS.

It is assumed that the parts have been collectively taken out of the pelvis, and that the partial peritoneal covering of the bladder has been removed.

The bladder, in a fairly dilated condition, measures about five inches in length and three in breadth.

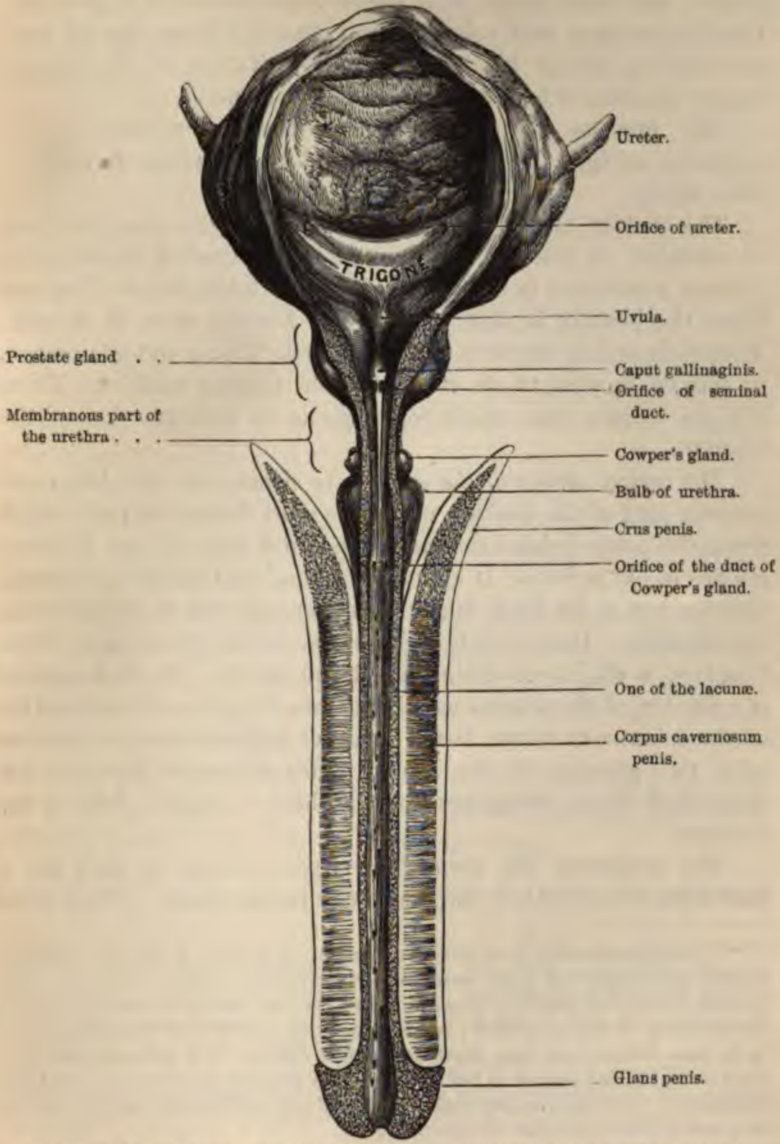
STRUCTURE OF THE BLADDER. The bladder is composed of a partial peritoneal coat, a muscular, and a mucous; between the last two there is a layer of connective tissue, which the old anatomists called the cellular coat.

The *serous or peritoneal* coat invests the posterior, lateral, and superior surfaces of the bladder; it is absent on the anterior and inferior aspect.

The *muscular* coat is situated beneath the serous, and consists of unstriped or involuntary muscular fibres, which interlace with each other in all directions. Their general arrangement is as follows:—An *outer*, or *longitudinal*, layer arises from the upper half of the circumference of the prostate and the neck of the bladder, and thence its fibres spread out longitudinally over the summit of the bladder, pass round its posterior aspect and base, to be inserted into the prostate in the male, and the vagina in the female. This layer is especially marked on the anterior and posterior surfaces of the bladder. Under this is a thin layer of *circular fibres*, especially developed near the neck, where they form a sphincter—*sphincter vesicæ.* Towards the sides of the bladder the two sets of fibres have a less definite arrangement, and form a kind of network: these, therefore, are the weakest

* Müller.

Fig. 101.



BLADDER AND URETHRA, LAID OPEN BY AN INCISION ALONG THE UPPER SURFACE.

parts of the bladder, and more liable to the formation of pouches.* The development and colour of the muscular fibres depend upon how far the subject has suffered from irritation of the bladder, or any obstruction to the expulsion of the urine.

The mucous coat is everywhere loosely connected to the muscular, except at the *trigone* of the bladder, where they adhere more firmly.

The bladder must be laid open by an incision along its front, to examine its interior. In a recently contracted bladder, the mucous membrane is disposed in irregular folds, which disappear when the bladder is distended. In a healthy state, it is pale; when inflamed, it becomes of a bright red. Under the microscope, its surface is seen to be studded with mucous follicles. These follicles secrete the thick ropy mucus in inflammation of the bladder.

The *vesical orifice of the urethra* is situated at the lower and anterior part of the bladder, not at the most dependent part, which forms the pouch behind the orifice, in which urine is apt to accumulate in old persons. It appears small and contracted in the fresh bladder, but if the little finger be introduced into it, it will dilate considerably. Immediately behind the orifice there is, in some bladders, a slight elevation, called the *uvula*. It is composed of a portion of the mucous membrane raised up by an accumulation of the submucous tissue, but is rarely of sufficient size to interfere with the passage of the urine. This elevation must be distinguished from enlargement of the third or middle lobe of the prostate.

The *orifices of the ureters* are situated about an inch and a half behind the urethra, and about two inches apart. These tubes

* These pouches arise in the following manner:—A portion of mucous membrane is protruded through one of the muscular interstices, so as to form a little sac. This is small at first, but gradually increases in size, because, having no muscular coat, it has no power of emptying itself; generally speaking, several such sacs are met with in the same bladder; and they sometimes contain calculi. If a calculus, originally loose in the bladder, happen to become lodged in a pouch by the side of it, a sudden remission of the symptoms may ensue. This explains our frequent inability to detect its presence at each examination with the sound.

perforate the coats of the bladder obliquely, and slant towards each other, standing out in relief under the mucous membrane.* A slight ridge proceeds from the orifice of each ureter to the neck of the bladder, looking like a continuation of the ureter itself. If the mucous membrane be removed from these ridges, we find that they are produced by muscular fibres. Sir Charles Bell,† who first drew attention to them, believed them to be of use in regulating the orifices of the ureters, and named them *the muscles of the ureters.*

Trigone of the Bladder. The ridges, converging from the ureters, form with a horizontal line, drawn between their orifices, a smooth triangular area, called, by a French anatomist,‡ the *trigone vesicale.* The mucous membrane of this area is more firmly adherent to the subjacent tissue than in other parts of the bladder, and is therefore perfectly smooth. It is more richly provided with blood-vessels and nerves than the rest of the bladder, and is endowed with more acute sensibility. This is why a stone is more painful when the bladder is empty; and in the erect, than in the recumbent position.

The bladder is supplied with blood by the *superior*, *middle*, and *inferior vesical* arteries. The superior comes from the unobliterated portion of the umbilical; the middle, from the superior vesical or the internal iliac; the inferior, from the anterior division of the internal iliac or the pudic.

The *veins* of the bladder form large plexuses around its neck, sides, and base, and empty themselves into the internal iliac veins. The *lymphatics* follow the course of the veins.

* This slanting of the ureters serves all the uses of a valve. The urine enters the bladder, drop by drop, but cannot return, because the internal coat is pressed against the other side of the orifice, so as to stop it. When the bladder becomes thickened, in consequence of difficulty in passing the water, it sometimes happens that the ureters lose their valvular direction, so that the urine, when the bladder contracts, is partly forced back up the ureters; the result is, that they become dilated, and the pelvis of the kidney also.

† 'Med. Chir. Trans.' vol. iii. He says, 'These muscles guard the orifices of the ureters by preserving the obliquity of the passage, and pulling down the extremities of the ureters according to the degree of the contraction of the bladder generally.'

‡ Lieutaud.

Its nerves are derived from the hypogastric and sacral plexuses; the former is chiefly distributed to the top, the latter to the neck and the bottom of the bladder.

PROSTATE. Having already examined the form, size, and relations of the prostate (p. 438), we have now to make out its lobes. There are two lateral lobes, and a third or middle lobe.* The middle one is pyriform in shape, unites the lateral lobes, and is situated between them and the urethra. In health, it does not appear like a separate lobe; but when abnormally enlarged, it projects toward the cavity of the bladder, and acts like a bar at the mouth of the urethra.

Make a longitudinal incision through the upper surface of the prostate to expose the urethra. This canal runs rather nearer to its upper than its lower surface, and is not of the same calibre throughout.† It forms a sinus in the interior of the prostate, described by anatomists as the *sinus of the prostate*. Along the floor of the sinus is a longitudinal ridge, about three-quarters of an inch in length, broad and elevated behind, but gradually fading in front. This is called the crest of the urethra, and the most prominent part of it is named the *veru montanum*, or *caput gallinaginis*, from its supposed resemblance to the head of a woodcock. On each side of this prominence the seminal ducts open. (p. 447).

Immediately in front of the caput gallinaginis, in the middle line, is a small opening which will admit a probe. It leads backwards into a little cul-de-sac or pouch in the substance of the prostate. This pouch is described as the analogue of the uterus, and called the *utriculus* or *sinus pocularis*. It is of a pyriform

* Attention was first attracted to this middle lobe, in England, by Sir Everard Home, whose account of it is published in the 'Philos. Trans.' for 1806. The preparation prepared by Sir Everard in illustration is preserved in the Museum of the Royal College of Surgeons in London, Physiol. Series, No. 2583 A. But the anatomy and effect of the enlargement of this part of the prostate gland is not a discovery of modern times. It was accurately described by Santorini in 1739, and subsequently by Camper, and is alluded to by Morgagni in the third book of his Epistles.

† This part of the urethra is about an inch and a quarter long, and about four lines in diameter.

shape, running backwards and upwards, with the narrowest part at the orifice, and its length is about five or six lines. It ascends between the lateral lobes of the prostate, and beneath the middle; its coats are comparatively thick with some muscular tissue enclosed in them, and it is lined with squamous epithelium. Practically it deserves attention, because in some persons it is large enough to catch the end of a small catheter. The minute orifices of the proper *ducts of the prostate*, from fifteen to twenty in number, are seen opening into the floor of the prostatic sinus.* The substance of the gland is permeated by the divisions and subdivisions of the ducts. They are not visible to the naked eye, but if traced out with the microscope, they are seen to terminate in blind sacculated extremities, upon which the capillaries ramify in rich profusion.†

The prostate is composed of muscular as well as glandular tissue. Nearly two-thirds of it is made up of plain muscular fibres, arranged in a circular manner round the urethra, at its vesical orifice, so as to form in conjunction with the vesical muscular tissue, a sphincter. The anterior part of the prostate is chiefly muscular, its fibres being continuous with those of the membranous part of the urethra. The prostate is remarkable for its dilatability. If a small incision be made through the anterior part of the gland, the *base being left entire*, the gland may be dilated by the finger sufficiently to allow the extraction of even large calculi.

Any change in the dimensions of the prostate affects the canal which runs through it, and more or less obstructs the flow of urine. If the entire gland be uniformly enlarged, the length of the pro-

* In the ducts of the prostate we often find small calculi, of a brown colour, consisting of phosphate of lime. Cases are sometimes met with in which these calculi by degrees attain a considerable size, and distend the prostate into a sac, which when examined by the rectum feels not unlike a bag of marbles.

† This was first demonstrated by the late Mr. Quekett. The same anatomist has also discovered that the secreting cells of the gland contain calculi of microscopic minuteness. He finds them, almost without exception, in the prostate at every period of life. For further detail concerning them consult the article 'Prostate' in Todd's 'Cyclopædia.'

static urethra is increased; if the enlargement preponderate at one part more than another, then the canal will deviate more or less from its natural track and assume a more angular or a lateral curve according to the part enlarged. When the middle lobe becomes enlarged, there arises, at the neck of the bladder, a growth which will, in proportion to its size, more or less obstruct the passage of the urine. In the efforts made to introduce a catheter into the bladder, it sometimes happens that the end of the instrument is pushed through this hypertrophied lobe.*

VESICULÆ SEMINALES. The external appearance of these bodies has been already described (p. 437). Respecting their structure, we find that they have an external coat derived from the recto-vesical fascia; a middle or fibrous, strong and somewhat elastic, and an internal or mucous. The mucous membrane is lined by a scaly epithelium, and presents a honey-combed structure, not unlike that of the gall-bladder. Unstriped muscular fibres exist in the fibrous investment of the vesiculæ seminales, for the purpose of expelling their contents, and are arranged partly transversely, on their posterior part, and partly longitudinally, in connection with the vesical muscular fibres. The duct emerges from the anterior part of the vesicula, and joins at an acute angle the vas deferens behind the prostate, to form the common ejaculatory duct (p. 435). The function of these bodies is twofold: they act as reservoirs for the semen, and secrete a fluid accessory to generation.

COWPER'S GLANDS. The glands of Cowper have been examined *in situ* in the dissection of the perineum (p. 425). They are placed close to the urethra, one on either side, immediately behind the bulb and between the two layers of the triangular ligament. They consist of a number of lobules united by firm connective tissue, and their collective size is somewhat larger than a pea. Each pours its secretion by a minute duct about an inch long into the bulbous part of the urethra. The use of these glands is analogous to that of the vesiculæ seminales and the prostate: namely, to pour into the urethra a fluid acces-

* See the Museum of St. Bartholomew's Hospital, Prep. 8 and 21, Series xxix.

sory in some way to generation. They are found in all mammalia, and in some—*e.g.* the mole—they increase in size periodically with the testicle.

URETHRA. The urethra is the canal which extends from the bladder to the end of the penis, and serves not only as the outlet for the urine, but to transmit the secretion of the testicles and the several glands accessory to generation. It is surrounded by different structures in different parts of its course. The first inch, or thereabouts, is surrounded by the prostate gland (p. 433); the second inch, which passes under the pubic arch, is surrounded by the compressor urethræ (p. 433); the remainder of its course along the penis is surrounded by erectile tissue, termed corpus spongiosum. Hence it is divided into the *prostatic*, the *membranous*, and the *spongy* parts. The length of the whole is about seven or eight inches, but this varies according to the condition of the penis.

The direction of the urethra, when the penis hangs flaccid, is like the letter S reversed; but if the penis be held straight, the canal forms only one curve through the pubic arch, with the concavity upwards. The degree of this curvature varies at different periods of life. In the child, the bladder being more an abdominal than a pelvic viscus, the curve forms part of a much smaller circle than in the adult; but it gradually widens as age increases, and catheters are shaped accordingly.* However, the parts, when in a sound state, will yield sufficiently to admit the introduction of a straight instrument into the bladder. A straight staff is sometimes used in lithotomy.

In its contracted state, the sides of the urethra are in close apposition; the appearance it presents on a transverse section differs in the different parts of its course. Through the glans it is flattened vertically; through the prostate it is crescentic, with the convexity upwards, owing to the veru montanum. But

* The sharper curve of the urethra in the child was well known to Camper. 'In recenter natis, vesica basi sua elatius sita, pedetentim descendit, unde necessario sequitur curvaturam urethræ majorem esse in junioribus quam in adultis.'—'Demon. Anat. Pathol.' lib. ii. p. 13.

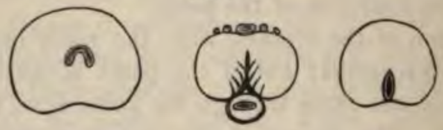
throughout the rest of its course the canal exhibits on section the appearance of a transverse slit (fig. 102).

The urethra must be laid open from end to end, to see that the canal is not of uniform calibre throughout. The external orifice is the narrowest, and the least dilatable part; so that the urine may be expelled in a jet. Therefore, any instrument which will enter the meatus ought to pass into the bladder, if there be no stricture. The junction of the membranous with the bulbous part is almost as narrow.

The *prostatic* and the *membranous parts* have been described (p. 438).

The *spongy part* of the urethra, so termed because it is surrounded by the erectile tissue of the corpus spongiosum, is about six inches long. That part of it running through the bulb is

FIG. 102.



A B C

TRANSVERSE SECTIONS OF THE URETHRA.

A. Through the prostate. B. Through the corpus spongiosum. C. Through the glans penis.

called the *bulbous portion*, and is the most dilatable part of the canal except the prostatic. In the centre of the glans penis the canal widens into a sinus, termed *fossa navicularis.*

The most *dilatable* part of the urethra is the prostatic. Even the narrowest parts of the canal must admit of considerable dilatation, since calculi of from three to four lines in diameter can pass through it.

The common ejaculatory ducts open into the prostatic part of the urethra, by the side of the veru montanum. The ducts of Cowper's glands open into the bulbous part. Besides these glands, a number of ducts open into the urethra, proceeding from small glands situated in the submucous tissue. These ducts, called *lacunæ*, are large enough to admit a bristle, and run in the same

direction as the stream of the urine. Most of them are on the lower surface of the urethra; but one, called *lacuna magna*, is on the upper surface, about one inch and a half down the canal.

Beneath the mucous membrane of the urethra is a layer of areolar tissue, the *submucous tissue*, external to which is a layer of vascular tissue of variable thickness; outside this is a layer of unstriped muscular fibres. It has been demonstrated that the urethra is surrounded throughout its whole course by muscular fibres of the involuntary kind. Therefore, the whole of the canal having a muscular coat similar to an intestine, any part of it is liable to spasmodic contraction.

The urethra is lined by columnar stratified epithelium, except near the glans, where there are papillæ, covered with squamous epithelium; this, therefore, is the most sensitive part.

Lastly, the urethra is provided with a closely-set network of *lymphatic vessels*, which has been demonstrated by quicksilver injections.* They run from behind, forwards, and join the lymphatics of the glans penis. Eventually, their contents are transmitted down the great trunks on the dorsum penis to the inguinal glands. This explains the pathology of a bubo.

THE PENIS. The skin of the penis is remarkably thin and extensible, and connected to the body of the organ by loose areolar tissue, destitute of fat. At the extremity the skin forms the prepuce, or foreskin, for the protection of the glans; † and the thin fold which passes from the under surface of the glans to the prepuce is called *frænum preputii*. The skin,

* Panizza, 'Osservazioni antropo-zootom.' &c, Pavia, 1830. This anatomist has also displayed by injections an extremely fine network of lymphatics which cover the glans penis. The interstices of this network are smaller than the diameter of the tubes.

† When the foreskin is, from birth, so tight that the glans cannot be uncovered, such a state is called a congenital phimosis. This condition occasions no inconvenience in childhood, but is apt, after puberty, to become troublesome and painful, so that it may become necessary to slit up the prepuce and set the glans at liberty. In persons who have a tight foreskin, it sometimes happens that, when the glans has been uncovered, the prepuce cannot be again drawn over it: this is called a paraphimosis. The neck of the glans becomes tightly girt; great distension and inflammation are the consequences unless the foreskin be reduced.

altered in character, is reflected over the glans, to which it is intimately adherent, and at the orifice of the urethra is continuous with the mucous membrane.

The surface of the glans is covered with minute vascular papillæ, endowed with keen sensibility by the dorsal nerves of the penis. Round its margin—termed the *corona glandis*—are a number of minute sebaceous glands, which secrete a substance called smegma preputii.

The bulk of the penis consists of two cylindrical bodies, of erectile structure, named from the appearance of their interior *corpora cavernosa*. In a groove along their under surface is lodged a third cylindrical body, the *corpus spongiosum*, composed of vascular spongy tissue, through which runs the urethra; an expansion of this at the end of the organ forms the *glans*. These structures, then—the corpora cavernosa and the corpus spongiosum—together form the penis; though the corpus spongiosum appears closely united to the corpora cavernosa, yet it is quite distinct from them, as shown in the transverse section (fig. 103).

The upper part of the penis is connected to the symphysis pubis by an elastic triangular ligament, called *ligamentum suspensorium penis*.

CORPORA CAVERNOSA. The *corpora cavernosa* constitute more than two-thirds of the bulk of the penis. Each commences posteriorly by a gradually tapering portion, called the *crus penis*, which is attached along a groove in the rami of the ischium and pubes, where it is embraced by the erector penis (p. 420). The two crura converge, come into apposition at the root of the penis, and then run together side by side to form the body of the organ. Anteriorly, each terminates in a rounded extremity, received into a corresponding depression in the glans, to which it is connected by fibrous tissue.

A section through the corpus cavernosum shows that its interior is composed of a delicate reticular structure, surrounded by a white fibrous and elastic coat, from half a line to a line in thickness.

The *septum pectiniforme* is a median vertical partition

between the two corpora cavernosa; it is only complete near the root of the penis; along the rest of the organ there are vertical slits in it, giving it the appearance of a comb: hence its name. Through the intervals in this partition the blood-vessels of the two corpora cavernosa communicate freely with each other.

From the interior of the fibrous coat a number of delicate septa, *trabeculæ*, pass inwards into the corpus cavernosum, intersecting each other in all directions, and forming a multitude of small spaces. The trabeculæ consist of fibrous lamellæ, with elastic and some non-striated muscular tissue. The spaces communicate freely with each other, as may be readily ascertained by blowing air into the penis; they are smaller and their component septa thicker at the circumference than in the centre of the corpora

Fig. 103.

1. Corpus cavernosum.
2. Corpus spongiosum urethræ.
3. Vena dorsalis.

4, 4. Dorsal arteries.
5, 5. Dorsal nerves.

TRANSVERSE SECTION THROUGH THE PENIS.

cavernosa, at the root than towards the glans. Each corpus cavernosum thus consists of innumerable spaces mainly occupied by dilated venous sinuses, from which the blood is conveyed by the dorsal vein, the prostatic plexus, and the pudendal veins. When the penis is flaccid, these spaces are empty; when it is erect, they are distended with blood.

The arteries of the corpora cavernosa come from the branches of the pudic (p. 427), which enter the inner side of each crus, and proceed forwards near the septum, distributing numerous ramifications. These are supported in the middle of the fibrous septa, and end, some in capillaries which convey their blood at once into the inter-trabecular spaces, others in tendril-like prolongations with dilated extremities which project into the

cavities of the veins. These arteries, called *helicine*, are absent near the glans, and are best marked at the root of the penis.

The blood from the inter-trabecular spaces of the penis returns partly through veins which pass out on the upper surface of the penis into the dorsal vein (which joins the prostatic plexus), partly through the deep veins which leave the inner side of each crus, and the bulb, to join the internal iliac.

CORPUS SPONGIOSUM. The *corpus spongiosum* is the erectile tissue which surrounds the urethra as it runs along the penis. It commences in the middle of the perineum, anterior to the triangular ligament, in a bulb-like form—*the bulb*—and at the end of the penis it expands to form the glans. It receives posteriorly an expansion from the triangular ligament, and presents a median groove, marking its development from two lateral halves. The urethra does not pass through the middle of the spongy body, but runs nearer to its upper surface. The bulb hangs more or less pendulous from the urethra, and is surrounded by the accelerator urinæ muscle (p. 420). In old persons it extends lower down than in children, and is, consequently, more exposed to injury in lithotomy.

The corpus spongiosum has a much thinner external coat than the corpus cavernosum, but resembles it very much in its internal appearance. The reticular structure, however, is somewhat finer. Its interior is composed of a plexus of minute tortuous veins. This is easily demonstrated by injecting the dorsal vein of the penis with wax. In this way we not only fill the spongy body, but also the glans and the large veins which form the plexus round the corona glandis.*

The chief *nerves* of the penis are the pudic, and its superficial perineal branch. The largest branches run along the dorsum to the surface of the glans: a few only enter the erectile tissue of the organ. This, it has already been mentioned (p. 446), is supplied

* In the Museum of the Royal College of Surgeons there is a preparation in which the glans penis is injected with quicksilver, clearly showing it to consist of a plexus of veins.—Physiol. Series, No. 2588 A.

by filaments of the sympathetic nerve proceeding from the hypogastric plexus.*

The *lymphatics* proceeding from the glans and the integument of the penis join the inguinal glands. The lymphatics of the glans communicate freely all round it: this explains why a venereal sore on one side sometimes affects the inguinal glands on the other. The deep lymphatics from the corpora cavernosa and the corpus spongiosum join the lymphatics of the pelvis.

DISSECTION OF THE FEMALE PERINEUM.

The *pudenda* in the female consist of folds of the integument, called the labia. Between these is a longitudinal fissure which leads to the orifices of the urinary and genital canals.

LABIA MAJORA. The pubic region is generally surmounted by an accumulation of fat, called *mons Veneris*, which is covered with hair. From this, two thick folds of skin descend, one on either side, constituting the *labia majora*, and gradually diminish in thickness towards the perineum. Their junction, about one inch above the anus, is called the posterior *commissure*, or *frœnulum labiorum*: it is generally torn in the first labour. The inner layer of the skin of the labium is thinner, softer, and more like mucous membrane than the outer: for this reason, whenever pus forms in the labium, the abscess bursts on the inner side. Where the labia are in contact, they are provided with small sebaceous glands, of which the minute ducts are observable on the surface.

CLITORIS. In form and structure the clitoris resembles the penis on a diminutive scale, being about an inch and a half long. It has, however, no corpus spongiosum, or urethra. Like the penis, it is attached to the sides of the pubic arch by two crura (fig. 104, p. 461), each of which is grasped by its special *erector clitoridis*. The crura are continued forward

* Krause has described end-bulbs on the nerves, and Pacinian corpuscles have likewise been discovered on the nerves of the glans.

like the corpora cavernosa of the male, and unite to form the body of the organ, which is surmounted by a small *glans*. The glans is provided with extremely sensitive papillæ, and covered by a little prepuce. Its dorsal arteries and nerves are large in proportion to its size, and have precisely the same course and distribution as in the penis. Its internal structure consists of a plexus of blood-vessels, which freely communicate with those of the labia minora; for one cannot be injected without the other.

LABIA MINORA. By separating the external labia, two small and thin folds of integument are exposed, one on either side, termed *labia minora*. These folds converge anteriorly, and form a covering for the clitoris, called *preputium clitoridis*; posteriorly they are gradually lost on the inside of the labia majora. They, unlike the labia majora, do not contain fat, but are composed of minute veins. Between the nymphæ and about the clitoris are a number of sebaceous glands.

Between the labia minora, and below the clitoris, is an angular depression called the *vestibule*, at the back of which is the *meatus urinarius*. Immediately below this is the vagina, of which the orifice is partially closed in the virgin by a thin fold of mucous membrane called the *hymen*.

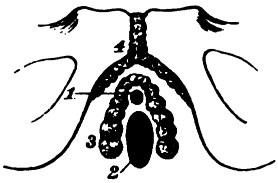
URETHRA. A smooth channel called the *vestibule*, three-quarters of an inch in length, leads from the clitoris down to the orifice of the urethra. This orifice, *meatus urinarius*, is not a perpendicular fissure like that of the penis, but rounded and puckered, and during life has a peculiar dimple-like feel, which assists us in finding it when we pass a catheter. You should practise the introduction of the catheter in the dead subject, for the operation is not so easy as might at first be imagined, provided the parts are not exposed. The point of the forefinger of the left hand should be placed at the entrance of the vagina, and the meatus felt for; when the catheter, guided by the finger, slips, after a little manœuvring, into the urethra. The canal is about one inch and a half in length, and runs along the upper wall of the vagina (p. 464). The two canals are in such close apposition that you can feel the urethra embedded in the

vagina like a thick cord. The urethra is slightly curved with the concavity upwards; but for all practical purposes it may be considered straight. Its direction, however, is not horizontal. In the unimpregnated state it runs nearly in the direction of the axis of the outlet of the pelvis; so that a probe pushed on in the course of the urethra would strike against the promontory of the sacrum. But, after impregnation, when the uterus begins to rise out of the pelvis, the bladder is more or less raised also in consequence of their mutual connection; therefore the urethra, in the latter months of utero-gestation, acquires a much more perpendicular course.

The female urethra is provided with a *compressor* muscle, similar, in origin and arrangement, to that which surrounds the

FIG. 104.

1. Meatus urinarius.
2. Vagina.



3. Bulb of vagina.
4. Clitoris with its two crura.

BULB OF THE VAGINA.*

membranous part of the urethra in the male. It also passes through the triangular ligament (fig. 105, p. 464). The prostate gland is wanting, but there are minute glands scattered around the neck of the bladder. In consequence of the wider span of the pubic arch, and the more yielding nature of the surrounding structures, the female urethra is much more dilatable than the male. By means of a sponge tent, it may be safely dilated to admit the easy passage of the fore-finger into the bladder. Advantage is taken of this great dilatability in the extraction of calculi from the bladder.

The mucous coat of the urethra is arranged in longitudinal folds, and is lined by squamous epithelium, which changes to the spheroidal variety near the bladder. Next to the mucous coat is

* Taken from an injected preparation in the Musée Orfila, at Paris.

a layer of elastic and non striped muscular fibres intermixed. Externally there is a plexus of veins bearing a strong resemblance to erectile tissue.

VAGINA. The vagina is the canal which leads to the uterus; at present, only the orifice of it can be seen. It is surrounded by a sphincter muscle, easily displayed by removing the integument. The muscle is about three-fourths of an inch broad, and connected with the cutaneous sphincter of the anus in such a manner that they together form something like the figure 8.

On each side of the orifice of the vagina, between the mucous membrane and the sphincter, is a plexus of tortuous veins, termed the *bulb of the vagina*, from its analogy to the bulb of the urethra in the male. This vaginal bulb is about an inch long and extends across the middle line between the meatus urinarius and the clitoris, as shown in fig. 104.

HYMEN. The hymen is a thin fold of mucous membrane which, in the virgin, extends across the lower part of the entrance of the vagina, about half an inch behind the fourchette. In most instances its form is crescent-shaped, with the concavity upwards. There are several varieties of hymen: sometimes there are two folds, one on either side, so as to make the entrance of the vagina a mere vertical fissure;* or there may be a septum perforated by several openings, *hymen cribriformis*, or by one only, *hymen circularis*. Again, there may be no opening at all in it, and then it is called *hymen imperforatus*. Under this last condition no inconvenience arises till puberty. The menstrual discharge must then necessarily accumulate in the vagina: indeed, the uterus itself may become distended by it to such an extent as even to simulate pregnancy.†

When the hymen is ruptured, it shrivels into a few irregular eminences, called *carunculæ myrtiformes*.

The presence of the hymen is not necessarily a proof of virginity, nor does its absence imply the loss of it. Cases are re-

* Such a one may be seen in the Museum of the College, Phys. Series, No. 2843.

† See Burns' Midwifery.

lated by writers on midwifery in which a division of the hymen was requisite to facilitate parturition. In Meckel's Museum, at Halle, are preserved the external organs of a female in whom the hymen is perfect even after the birth of a seven-months' child.

BARTHOLIN'S OR DUVERNEY'S GLANDS.

Between the orifice of the vagina and the erector clitoridis is embedded in the loose tissue on either side a small gland,* which corresponds to Cowper's gland in the male. Each is about half an inch in length. Its long slender duct runs forwards and opens on the inner side of the nympha. In cases of virulent gonorrhœa these glands are apt to become diseased, and give rise to the formation of an abscess in the labium, very difficult to heal.

The description of the perineal branches of the pudic vessels and nerves, given in the dissection of the male perineum, applies, *mutatis mutandis*, to the female, excepting that they are proportionably small, and that the artery which supplies the bulb of the urethra in the male is distributed to the bulb of the vagina in the female.

DISSECTION OF THE FEMALE PELVIC VISCERA.

The internal organs of generation—viz. the vagina, uterus, and its appendages—should now be examined.

Their relative position should first be noticed; and afterwards, their special anatomy.

GENERAL POSITION OF THE UTERUS AND ITS APPENDAGES.

The uterus is interposed between the bladder in front, and the rectum behind. From each side of it a broad fold of peritoneum extends transversely to the side of the pelvis, dividing that cavity into an anterior and a posterior part. These folds are called the *broad ligaments* of the uterus (fig. 106, p. 473). On the posterior surface of the ligament are the ovaries, one on each side. They are completely covered by peritoneum, and suspended to the ligament by a small peritoneal fold. Each ovary is attached to the uterus by a cord termed the *ligament of the ovary*. Along the upper

* See Tiedemann, 'Von den Duverneyschen Drüsen des Weibs.' Heidelberg, 1840.

part of the broad ligament we find between its layers a tube about four inches long, called the *Fallopian tube*, which conveys the ovum from the ovary into the uterus. For this purpose, one end of it terminates in the uterus, while that nearer to the ovary expands into a wide mouth, furnished with prehensile fringes—*fimbriæ*—which, like so many tentacles, grasp the ovum as soon as it escapes from the ovary. One of these fimbriæ is attached to the ovary. Lastly, there run up to the ovary, between the layers

Fig. 105.

VERTICAL SECTION THROUGH THE FEMALE PELVIC VISCERA.

of the broad ligament, the ovarian vessels, which arise from the aorta in the lumbar region, like the spermatic arteries in the male, because the ovaries are originally formed in the loins.

On the anterior surface of the broad ligament, on either side between its layers, is the *round ligament* of the uterus. This cord proceeds from the fundus of the uterus, anterior to the Fallopian tube, through the inguinal canal, like the spermatic cord in the male, and terminates in the mons Veneris. Besides

one or two small blood-vessels, it contains muscular fibres analogous to those of the uterus: these increase very much in pregnancy, so that, about the full term, the cord becomes nearly as thick as the end of the little finger. In early life, the round ligament receives a covering from the peritoneum which advances in a tubular form into the inguinal canal. It corresponds to the processus vaginalis of the peritoneum in the male. It is called the *canal of Nuck*, and is generally obliterated in the adult. It may be the seat of a hernia.

SIDE VIEW OF THE FEMALE PELVIC ORGANS. After the removal of the innominate bone, as described at p. 428, the vagina, rectum, and bladder should be moderately distended, and a catheter passed into the urethra. This done, the reflections of the peritoneum must be traced.

REFLECTIONS OF THE PERITONEUM. From the front of the rectum the peritoneum is reflected on to a small part of the posterior wall of the vagina, thus forming what is called the *recto-vaginal pouch*. From the vagina the peritoneum is continued over the posterior surface, but only about half-way down the *front* of the uterus; thence it is reflected over the posterior surface of the bladder, on to the wall of the abdomen. Laterally it is reflected from the uterus to the sides of the pelvis, forming the broad ligaments (p. 473).

In cases of ascites the fluid might distend the recto-vaginal pouch, and bulge into the vagina, so that it would be practicable to draw it off through this channel.

PELVIC FASCIA. To the description of the fascia already given in the dissection of the male pelvis (p. 430) nothing need be added except that from the side of the pelvis it is reflected over the side of the vagina and the uterus, as well as the bladder.

It is this fascia which in great measure supports the uterus in its proper level in the pelvis. When, from any cause, the fascia becomes relaxed, there is a liability to prolapsus uteri.

LEVATOR ANI. For the description of this muscle see p. 439.

BLADDER. The female bladder is broader transversely, and, upon the whole, more capacious than the male.

The vesical plexus of veins is not so large, and there are no vasa deferentia or prostate gland. The short urethra has a constrictor muscle, as in the male, and is supported in a similar manner by the pelvic fascia.

VENOUS PLEXUS ABOUT THE VAGINA.

Though the veins round the neck of the bladder are comparatively small in the female, attention should be directed to the plexus of large veins which surround the vagina. They communicate freely with the veins about the rectum, and empty themselves into the internal iliac. Their congestion in pregnancy sufficiently accounts for the dark colour of the vagina and the external organs, and the frequent occurrence of hæmorrhoidal tumours.* These veins must be removed, with the connective tissue in which they are embedded, before a clear view of the parts can be obtained.

URETHRA.

The urethra has already been described (p. 460). But, in the side view of the parts, we have the opportunity of observing how closely the bladder and urethra are connected to the upper wall of the vagina; and we can understand how, in cases of protracted delivery, it sometimes happens that the contiguous coats of the bladder and the vagina give way, and that a fistulous communication remains between them, through which urine constantly dribbles.

VAGINA.

It is necessary to slit open the whole of the vagina along the side, to obtain a clear idea of the manner in which it embraces the lower end of the uterus, and of the extent to which the neck of the uterus projects into it.

The length of the vagina, in the unimpregnated adult, is, on an average, about 4½ inches. It may be more, or less; the difference in each case depending upon the depth of the pelvis, the stature and age of the individual. Owing to the curved direction of the vagina, the anterior wall is about an inch shorter than the posterior. The vagina, however, is never so long that we cannot,

* During pregnancy, varicose tumours may form even in the vagina. In the Berlin 'Med. Zeitung,' 1840, No. 11, a case is related of a woman who, at the sixth month, bled to death from the bursting of a large vein in the vagina. Other cases of the kind are related by Siebold.

during life, feel the neck of the uterus projecting at the top of it; higher up, or lower down, according to circumstances. For instance, it is a little lower down in the erect than in the recumbent position; again, in the early months of utero-gestation, the uterus descends a little into the vagina, so that this canal becomes shorter: the reverse holds good when the uterus begins to rise out of the pelvis.

The axis of the vagina is slightly curved with the concavity upwards; it corresponds with the axis of the outlet of the pelvis.

The width of the vagina is not uniform throughout. The narrowest part is at the orifice; it is also a little constricted round the neck of the uterus. The widest part is about the middle: here a transverse section through it presents the appearance of a broad horizontal fissure. If, therefore, you would insert the bivalve speculum with the least amount of pain, the blades of the speculum should be vertical when introduced into the orifice, and afterwards turned horizontally.

UTERUS. The uterus is the hollow muscular organ which receives the ovum, retains it for nine months to bring it to maturity, and then expels it by virtue of its muscular walls. Its situation and peritoneal connections have been described (p. 463). Its axis slants forwards, so that, upon the whole, the axis of the vagina and uterus describes a curve nearly parallel to the axis of the pelvis. The uterus, then, is so placed that it is ready to rise out of the pelvis into the abdomen after the embryo has attained a certain size.

The uterus in the unimpregnated state is pyriform, or rather triangular with the angles rounded, and is somewhat flattened antero-posteriorly. Its average size is about three inches long, two inches broad, and one inch thick, at the upper part; but there is variety in this respect, arising from age, the effect of pregnancies, and other causes.

For convenience of description, the uterus is divided into the fundus, the body, and the cervix. The term *fundus* is applied to the broadest part, which lies above the level of the Fallopian tubes (p. 464). The *body* is the central part, while the *cervix* is

the narrow part which projects into the vagina. The vagina is very closely attached round the neck of the uterus: observe that it is attached higher up behind than in front. The mouth of the uterus, *os uteri*, is at the apex of the neck.

Postponing for the present the examination of the interior of the vagina and uterus, let us pass on to the vessels and nerves of these organs.

UTERINE AND VAGINAL ARTERIES.

In addition to the ovarian arteries (which correspond to the spermatic arteries in the male) given off from the abdominal aorta (p. 385), each internal iliac artery furnishes a branch to the uterus and another to the vagina.

The *uterine* artery proceeds from the anterior division of the internal iliac, towards the neck of the uterus, between the layers of the broad ligament, and then ascends tortuously by the side of the uterus, giving off numerous branches to it, which anastomose freely with each other, and with a small branch from the ovarian artery. The fundus of the uterus is mainly supplied with branches from the ovarian arteries.

The *vaginal* artery ramifies along the side of the vagina, and distributes branches to the lower part of the bladder and the rectum.

The *veins*, corresponding with the arteries, form the uterine and vaginal plexuses, which empty themselves into the internal iliac.

NERVES OF THE UTERUS.

The nerves of the uterus are derived from the third and fourth sacral nerves, from the hypogastric and ovarian plexuses (p. 408). They accompany the blood-vessels in the broad ligament to the neck of the uterus, and ascend with them along its sides.

Some small filaments continue with the vessels, and form around them plexuses, upon which minute ganglia are found.* But most of the nerves soon leave the vessels, and, subdividing, sink into the substance of the uterus, chiefly about its neck and the lower part of its body. A branch may be traced passing up to the fundus of the uterus, and another to the Fallopian tube.

* Beck, 'Philosophical Transactions' for 1846.

The nerves of the uterus enlarge during pregnancy like the arteries. Surgically speaking, the os uteri may be said to have no nerves; for it is insensible to the cautery and to the knife.

The *lymphatics* of the uterus are small in its unimpregnated state, but greatly increase in size when it is gravid. Those from the fundus and the ovaries proceed with the ovarian vessels to the lumbar glands; thus explaining the affection of these glands in ovarian disease. Those from the body and the lower part of the uterus accompany the uterine arteries, and join the glands in the pelvis; some, however, run with the round ligament to the groin; hence, in certain conditions of the uterus the inguinal glands may be affected.

STRUCTURE OF THE VAGINA, UTERUS, OVARIES, AND FALLOPIAN TUBES.

The uterus, vagina, ovaries, and Fallopian tubes should now be collectively removed from the pelvis for the purpose of examining their internal structure.

The vagina having already been laid open (p. 466), we observe that it is lined by a mucous membrane of a pale rose colour; and that it is rough and furrowed, especially near the orifice. Two ridges, *columnæ rugarum*, run one along its anterior, another along its posterior wall. From either side of these proceed a series of transverse ridges—*rugæ*—with rough, jagged margins directed forwards. They are well marked in virgins, but repeated parturition and increasing age gradually smooth them down. The use of the vaginal rugæ is to excite the sensibility of the glans in coition. They themselves also possess keen sensibility, being richly endowed with papillæ.

The mucous membrane is provided with numerous papillæ, conical and filiform, and covered with a thick lining of squamous epithelium. In the submucous tissue is an abundant supply of muciparous glands, which increase in number and size towards the uterus.

The chief strength of the vagina depends upon a fibro-cellular coat, about one-twelfth of an inch in thickness. If this coat be minutely injected, we find that it is composed mainly of the inosculations of blood-vessels, so much so that by some it is regarded

as erectile tissue. In this coat, muscular fibres, longitudinal and circular, have been demonstrated. The orifice of the vagina is surrounded by a circular muscle, called *sphincter vaginæ* (p. 462). Superiorly, the vagina is intimately attached to the neck of the bladder, while to the rectum it is but loosely connected.

UTERUS. Before the uterus is laid open, examine the shape of that portion of the neck which projects into the vagina. The back part of the cervix appears to project into the vagina more than the front; but this arises from the vagina being attached higher up posteriorly. If the vagina were cut away from the cervix, the anterior lip of the uterus would appear to project a trifle more than the posterior. For this reason, as well as on account of the natural slope forwards of the uterus, the front lip is felt first in an examination per vaginam.* The length, however, and the general appearance of the vaginal part of the cervix vary according to the age; it is also considerably altered by parturition. In the adult virgin it is smooth and round, and projects about half an inch: its mouth is a small transverse fissure. But after parturition, it loses its plumpness, the lips become flaccid and fissured, and the mouth larger than it was before.†

The uterus must now be laid open by a longitudinal incision, to examine its interior. In doing so, observe the thickness of its walls, which is greatest towards the fundus. Before coming into the proper cavity in the body of the uterus, slit up a long narrow canal which leads up into it through the neck. This canal, which

* This is the only way to reconcile the discrepancies one meets with in anatomical works, respecting the comparative length of the lips of the uterus. Krause, Weber, Busch, and others, say the anterior is the longer; Mayer, Meckel, Quain, and others, the posterior.

† Instances are recorded in which the neck of the uterus is preternaturally long. It has been known to project even as much as an inch and a half into the vagina. In such cases it gradually tapers, and terminates in a very narrow mouth. This is said to be one cause of sterility, and it is recommended either to dilate the mouth, or to cut off a portion of the neck. In support of this opinion, it is stated that Dupuytren was once consulted by a lady on account of barrenness; finding the neck of the uterus unusually elongated, he removed a portion of it, and shortly the lady became pregnant. (Hyrtl, 'Handbuch der top. Anatom.')

is about an inch in length, is not of the same dimensions throughout: it is dilated in the middle, and gradually narrows towards each end. The upper end, which leads into the body of the uterus, is called *os internum*; the lower end, which leads into the vagina, *os externum*. The passage is called the *canal of the cervix*. It remains unchanged in pregnancy for some time after the cavity in the body has expanded, but gradually disappears with the increasing size of the embryo.

The shape of the *cavity* in the body of the uterus is triangular, with the apex towards the cervix. In a virgin uterus the cavity is very small, and its sides are convex; but in a uterus which has borne many children, the cavity has lost the convexity of its sides, and has increased in capacity. Each angle at the base is somewhat prolonged, and leads to the minute opening of the Fallopian tube. This prolongation of the angles is noticed more or less in different females, and is the last indication of the two horns of the uterus in some orders of mammalia.

The interior of the uterus is smooth at the fundus; but the reverse at the cervix. Here there is a central longitudinal ridge, both in front and behind (as in the vagina); from these, other closely set oblique ridges curve off laterally, like the branches of a palm-tree. In olden time it was called '*arbor vitæ*.' The roughness produced by these ridges occasions an impression as though we were touching cartilage when a sound is introduced into the uterus.

The *neck* of the uterus is provided with small muciparous glands, of which the minute ducts open in the furrows between the ridges referred to. The secretion of these glands is glairy, albuminous, and slightly alkaline. Soon after impregnation, the secretion becomes so firm as to plug the mouth of the uterus, but shortly before and during parturition it is poured out in great quantity, to facilitate the passage of the child. It happens occasionally that one or more of the ducts of these glands become obstructed, and then dilate into small transparent vesicles, which gradually rise to the surface and burst.*

* These were first described by Naboth, and supposed to be true ova: hence their name *ovula Nabothi*. 'De sterilitate mulierum.' Lips., 1707.

The *mucous membrane* of the uterus is more delicate and softer than that of the vagina, with which it is continuous, and is closely united to the subjacent tissue. The greater part of it is lined by a columnar ciliated epithelium, but that which lines the lower part of the cervix is squamous, like that of the vagina. Examined with a lens, the mucous membrane lining the body of the uterus is seen to be covered with minute follicles or tubes (*uterine glands*) arranged at right angles to its surface. These tubes pass outwards in a more or less spiral manner, some of them appearing branched and dilated at their extremities. They become greatly developed shortly after impregnation, and take an important part in the formation of the *membrana decidua.*

The greater part of the walls of the uterus consists of non-striped or involuntary muscular fibres, which are chiefly aggregated at the fundus, less so at the junction of the Fallopian tubes. The texture of these fibres is so close and so interwoven that in the unimpregnated uterus it is useless to attempt to trace them. The fibres are arranged in three layers, an external, a middle, and an internal. The *external* layer, placed immediately beneath the peritoneum, is thin, and its fibres run transversely round the uterus, some of them being continued in an oblique direction into the round and broad ligaments. A band of longitudinal fibres passes from the anterior surface of the uterus round the fundus to its posterior aspect. The *middle* layer runs in all directions, and chiefly surrounds the blood-vessels. The *internal* and thickest layer is composed mainly of concentric circles which surround the orifices of the Fallopian tubes; at the cervix its fibres are arranged transversely, forming a sphincter. Upon the whole their collective disposition is such as to exert equal pressure on all sides, when called into operation.

At the same time that they expel the fœtus, the muscular fibres perform another very important function: they close the large venous sinuses consequent upon the great increase in the amount of blood during pregnancy. Therefore, little hæmorrhage accompanies the expulsion of the placenta, provided it have been

attached to the fundus or the side of the uterus. But everyone knows the danger of what is called *placenta prævia*. Here, the placenta, placed entirely or partly over the orifice of the uterus, is attached to a part of the organ which must of necessity expand during labour; and every uterine contraction increases, instead of checking, the bleeding. For the same reason, paralysis of the muscular fibres in immediate connection with the placenta, be it where it may, is likely to be a source of serious hæmorrhage in parturition.

FALLOPIAN TUBES.

The *Fallopian tubes* or *oviducts* are situated, one on each side, along the upper border of the

FIG. 106.

DIAGRAM OF THE UTERUS, ITS BROAD LIGAMENTS, THE OVARIES AND FALLOPIAN TUBES. SEEN FROM BEHIND.

1. Uterus.
2. Ovary, with its ligaments.
3. Fallopian tube.
4. Fimbriated extremity of Fallopian tube.
5, 5. Broad ligament.
6. Vagina.

broad ligament of the uterus, and convey the ovum from the ovary to the uterus (fig. 106). They are about three or four inches in length. One end opens into the uterus; the other terminates in a wide funnel-shaped mouth, surrounded by fringe-like processes called the *fimbriated extremity*. This termination of the Fallopian tube extends about an inch beyond the ovary; and, by floating it in water, one or two of the fimbriæ may be seen connected with the outer end of the ovary. If the Fallopian tube be opened from the expanded end, and a probe introduced into it, you will

find that the tube runs very tortuously at first, then straight into the uterus, gradually contracting in size, so that the uterine orifice scarcely admits a bristle. Its mucous lining is gathered into longitudinal wavy folds, especially at the ovarian end, and is provided with a columnar ciliated epithelium. The free end of the tube communicates with the cavity of the peritoneum. This is the only instance where a mucous membrane is directly continuous with a serous one. It explains how the embryo may escape into the peritoneal cavity; though this is an extremely rare occurrence. It also explains what is said to have occurred: namely, the escape of the fluid in dropsy through the Fallopian tubes. In a well-injected subject, the Fallopian tubes are seen to be well supplied with blood from the ovarian arteries. They are provided with non-striped muscular fibres: the outer layer being arranged longitudinally; the inner, in circles.

OVARIES. The ovaries (called by Galen, *testes muliebres*) are situated at the back of the broad ligament of the uterus, between its two layers, but more or less suspended by a short fold of peritoneum. Besides this, they are connected on their inner side to the uterus by a thin cord, called the *ligament* of the *ovary*. They are oblong, with the long axis transverse, and a little smaller than the testicles. In females who have not often menstruated, their surface is smooth and even; in after-life, they become puckered and scarred by the repeated escape of the ova.

The ovary is about an inch and a half long, and weighs about a drachm and a half. It has nearly the same coverings as the testicle: viz. a serous coat, which is covered with columnar epithelium, and beneath it a proper fibrous coat, the *tunica albuginea*. If a section be made through the ovary, you find that it contains transparent vesicles, embedded in a soft fibro-nuclear tissue, remarkably vascular when well injected, called the *stroma* of the ovary. The outer part of the ovary is chiefly occupied by these vesicles; the central part, in which there are very few, is composed almost entirely of the stroma.

The transparent vesicles just alluded to are the ovisacs or

*Graafian vesicles.** They vary in number from eight to thirty, and in size from that of a pin's head to a pea.† The smallest are near the centre; but as they advance towards maturity, they gradually approach the surface, increasing at the same time in size. Their proper tunic is very vascular and lined by several layers of granular prismatic epithelium cells, called the *tunica granulosa*, and they contain a transparent albuminous fluid. On examining the contents of one of the larger vesicles under the microscope, you find in it the *ovum* or germ,‡ surrounded by a layer of granular cells called the *discus proligerus*. It is this ovum which, escaping from the Graafian vesicle on the surface of the ovary, is grasped by the fimbriated end of the Fallopian tube and conveyed into the uterus. The ruptured vesicle is converted soon afterwards into a yellowish-looking mass called *corpus luteum*, which persists for a while, and degenerates afterwards into a small stellate fibrous cicatrix.

The ramifications of the ovarian artery through the ovary are remarkable for their convolutions: they run in parallel lines, as in the testicle. Its nerves are derived from the ovarian plexus. The ovarian veins form, like the spermatic veins, near the ovary the pampiniform plexus, and then terminate, the right in the inferior vena cava, the left in the renal.

DISSECTION OF THE ABDOMINAL VISCERA.

THE LIVER.

The liver is the largest gland in the body, and in the adult weighs from fifty to sixty ounces. Its surface is entirely covered by peritoneum, except a small part behind, which is connected to the diaphragm and the upper part of the right kidney by cellular tissue, and, again, in the hollow for

* So called after De Graaf, a Dutch anatomist, who discovered them in 1672, and believed they were the true ova.

† From the $\frac{1}{100}$th to the $\frac{1}{20}$th of an inch in diameter.

‡ This was first distinctly pointed out by Von Baer in 1827.

the gall-bladder. Behind, the liver is thick and round, but towards the front it gradually slopes to a sharp border. The upper surface is smooth and convex, in adaptation to the diaphragm, and is marked by a white line which indicates its division into a right and left lobe, the right being the larger. The under surface is irregular and marked by five fissures which map out the five lobes (fig. 107):—1. The *longitudinal fissure*, dividing the right from the left lobe, contains the round ligament (the remains of the umbilical vein). 2. The continuation of the longitudinal fissure to the posterior border of the liver, contains the remains of what was, in the fœtus, the ductus venosus, and is therefore called the *fissure for the ductus venosus*. 3. The hollow or *fissure for the gall-bladder*. In the same line with this is, 4, the *fissure for the inferior vena cava*, which passes obliquely inwards towards the posterior border of the liver. 5. The *transverse* or *portal fissure* unites the other fissures, and transmits the great vessels which enter the liver in the following order: in front is the hepatic duct, behind is the vena porta, and between them the hepatic artery. The relative position of these fissures (the liver being *in situ*) may be best impressed on the memory by comparing them collectively to the letter H. The transverse fissure represents the cross-bar of the letter; the longitudinal fissure and the fissure of the ductus venosus represent the left bar; the fissures of the gall-bladder and vena cava make the right bar.

FISSURES.

LOBES.

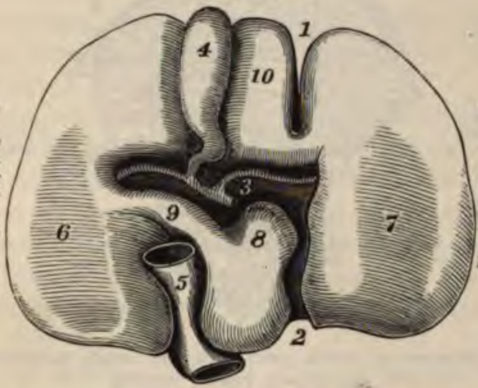
The lobes of the liver, five in number, are also seen on its under surface. The *right* lobe, much larger than the *left*, is separated from it by the longitudinal fissure. On the under surface of the right lobe are two shallow *fossæ*; the anterior is for the hepatic flexure of the colon, the posterior for the right kidney. The remaining lobes may be considered as forming parts of the right lobe, and are the *lobulus Spigelii*, the *lobulus caudatus*, and the *lobulus quadratus*. The *lobulus Spigelii* is placed between the fissures for the ductus venosus, and the vena cava, and the transverse fissure; and, behind the transverse fissure, it is connected to the right lobe by a ridge—the

lobulus caudatus. The *lobulus quadratus* is situated between the gall-bladder, the longitudinal, and the transverse fissure. This lobe is occasionally connected with the left lobe by a bridge of hepatic substance (*pons hepatis*) which arches over the longitudinal fissure.

The liver has five *ligaments*, of which the coronary, the right and left lateral, and the falciform are reflections of the peritoneum; the fifth is the round ligament in the anterior free border of the falciform ligament; it consists of the remains of the umbilical vein. The ligaments have been previously described (p. 377).

Fig. 107.

1. Longitudinal fissure.
2. Continuation of the longitudinal fissure (for the ductus venosus).
3. Transverse fissure.
4. Gall-bladder.



5. Venacava in its groove.
6. Right lobe.
7. Left lobe.
8. Lobulus Spigelii.
9. Lobulus caudatus.
10. Lobulus quadratus.

DIAGRAM OF THE UNDER SURFACE OF THE LIVER.

The liver is surrounded by a thin areolar coat or capsule, best seen on those parts of it not covered with peritoneum. This coat is connected to the areolar tissue which surrounds the lobules, but does not send down partitions to form a framework for the interior of the gland. It is continuous, at the transverse fissure, with the sheath of loose areolar tissue called *Glisson's capsule*, which surrounds the vessels as they enter that fissure, and incloses them in a common sheath in their ramifications through the liver.

The inter-lobular areolar tissue is exceedingly delicate; hence

the great liability of the liver to be lacerated by external violence, or by the action of the abdominal muscles.

LOBULES. The liver consists of an aggregation of small polyhedral masses called *lobules*, which range from $\frac{1}{20}$ to $\frac{1}{10}$ of an inch in diameter. These lobules are marked out by septa of areolar tissue, and in a transverse section have the appearance of mosaic pavement (fig. 108); but in a perpendicular section they somewhat resemble an oak-leaf (fig. 109). Each lobule consists of a minute plexus of blood-vessels, ducts, and cells

FIG. 108.

a. Inter-lobular vein.

b. Intra-lobular or central vein.

TRANSVERSE SECTIONS OF THREE LOBULES OF THE LIVER, MAGNIFIED TO SHOW THE PORTAL VENOUS PLEXUS.

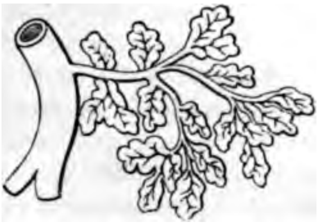
(After Kiernan.)

—*hepatic cells*—which latter fill up the spaces between the ramifications of the vessels. It will facilitate the understanding of the branchings of the different hepatic vessels, if it be borne in mind, 1, that the portal vein, hepatic artery, and hepatic duct, ramify together from first to last—inclosed in a sheath of areolar tissue, called *Glisson's capsule*; 2, that the hepatic veins run alone from first to last, and terminate in the inferior vena cava as it passes under the liver.

The *portal vein*, on entering the substance of the liver, gives off numerous small branches, which pass between the lobules and

form the *inter-lobular* or *peripheric veins* (fig. 108). The interlobular veins give off a minute capillary network which penetrates into the interior of the lobules and freely communicates in the centre with a single trunk called the *intra-lobular* or *central vein*. This central vein returns the blood from the lobule, and opens immediately into a *sub-lobular* vein, larger or smaller as the case may be, upon which the lobule is sessile (fig. 109). The sub-lobular veins empty themselves into the smaller hepatic veins; these unite to form the main hepatic trunks which open into the inferior vena cava.

FIG. 109.



LONGITUDINAL SECTIONS OF THE LOBULES OF THE LIVER. INTRA-LOBULAR VEINS SEEN JOINING THE SUB-LOBULAR.

The *hepatic artery*, entering the liver at the transverse fissure, divides and subdivides with the portal vein and the biliary ducts, and ramifies with them between the lobules. The artery distributes branches which supply the coats of the hepatic vessels and Glisson's capsule—*vaginal branches*—and the capsule of the liver—*capsular branches*; other branches pass into the lobules and join the capillary network which leads to the radicles of the central vein.

The minute capillary network which forms the basis of the lobule radiates from the periphery to the centre. The capillaries average about $\frac{1}{2500}$ of an inch.

The *biliary ducts* form a close network round the circumference of each lobule. From this network of *biliary capillaries* branches proceed on all sides, and accompany the portal vein. Doubt still exists as to the commencement of the ducts. The prevalent opinion is that they begin within the lobules by a minute plexus, surrounded by hepatic cells. The interior of each lobule—that is, the space left between the several vessels—is filled by the hepatic cells. They are nucleated, and have a diameter varying from $\frac{1}{850}$ to $\frac{1}{1000}$ of an inch. They contain more or less granular-matter, and in some cases fat-globules: when these

accumulate in large quantities, they constitute what is called a fatty liver. The office of these cells is to separate the bile from the blood, and, when filled with bile, to discharge their contents into the hepatic ducts.*

The *lymphatics* of the liver, superficial and deep, commence in the spaces in the interior of the lobule, accompany the interlobular vessels, and pass out at the transverse fissure. The superficial lymphatics are in connection with the areolar sheath and the upper surface of the liver.

The *nerves* of the liver are derived from the pneumogastric, chiefly the left; and from the hepatic plexus which comes from the cœliac plexus. These plexuses enter the liver at the transverse fissure, surround the hepatic artery and the portal vein, and accompany these vessels in their ramifications through it. The ultimate termination of these nerves is not known.

The *functions* of the liver may be thus briefly expressed:— 1. It renders the albuminous matter (albuminose) brought to it by the portal vein capable of being assimilated. 2. It forms a substance, *glycogen*, easily converted into sugar, which passes into the hepatic veins, and being consumed, helps to maintain animal heat. 3. It secretes the bile, which assists in converting the chyme into chyle, and reducing it into a state fit to be absorbed by the lacteals. 4. The bile acts as a natural aperient. 5. The bile is an antiseptic, and probably prevents the decomposition of the food during its passage through the intestine.

GALL-BLADDER. The gall-bladder, or reservoir for the bile, is confined by the peritoneum in a slight depression on the under surface of the right lobe of the liver (p. 477). It is pyriform in shape, is about four inches long, and capable of holding about $1\frac{1}{2}$ oz. of fluid. Its narrow end, or neck, makes a bend downwards, and terminates in a duct, called the *cystic*, which, after a course of about an inch and a half, joins the hepatic duct at an acute angle (fig. 81, p. 387). The common duct, *ductus communis choledochus*, formed by their union, is about three or

* For further information on this subject see the original observations of Kiernan in the 'Philosoph. Trans.' for 1833.

four inches long, and opens into the back of the descending part of the duodenum, after running very obliquely through the coats of the bowel.

Exclusive of its partial peritoneal covering, the gall-bladder has two coats: the outer, consisting of connective tissue, contains involuntary muscular fibres, which run mainly in the long axis of the gall-bladder; the inner is the mucous coat.

It is supplied with blood from the cystic branch of the right hepatic artery; its blood is returned by the cystic vein which opens into the vena portæ; its nerves are derived from the cystic branches of the hepatic plexus.

The gall-bladder should now be laid open. Its mucous membrane is generally tinged yellow by bile, and gathered into ridges which give it a honey-combed appearance. This appearance is most marked in the middle of the gall-bladder: in the depressions between the ridges may be seen, with a lens, numerous openings leading down to mucous follicles. It is covered by columnar epithelium, which secretes an abundance of viscid mucus. At the bend of the neck of the gall-bladder, both its coats project very much into the interior, making the opening considerably narrower than it appears to be outside. In the cystic duct, the mucous membrane presents a series of folds, so arranged, one after the other, as to form a complete spiral valve. The probable use of this is to prevent the too rapid flow of the bile. The gall-bladder appears to serve mainly as a reservoir for the bile, while digestion is not going on. The bile becomes during its sojourn in the gall-bladder very viscid and intensely bitter.

SPLEEN. The spleen is a very vascular sponge-like organ, and belongs to the class of ductless glands. It varies in size according to the amount of blood in it, fluctuating in weight, consistently with health, between five and ten ounces. It is of a reddish-blue colour. It is more or less elliptical in shape, and in its natural position is placed with its long axis nearly vertical. Its outer surface, which corresponds to the ninth, tenth, and eleventh ribs, is adapted to the diaphragm and ribs, and is smooth and convex; its inner, adapted to the great end of the

stomach, is concave, and divided into an anterior and a posterior portion by a vertical fissure—the *hilus*—at the bottom of which are large openings through which the vessels enter and emerge from the spleen.

The spleen is invested with two coats, a peritoneal and a fibrous. The *peritoneal* coat entirely covers the organ, except at the hilus, from which it is reflected to the stomach, forming the gastro-splenic omentum. Its *fibrous* capsule, *tunica propria*, not only covers the spleen, but sends throughout its substance fibrous cords (*trabeculæ*), which cross in various directions, and thus form an intricate network of what are called *trabecular spaces*. Besides this, the trabeculæ form sheaths and supports for the splenic vessels throughout their ramifications. The whole of this fibrous framework is exceedingly elastic to admit of the varying size of the spleen, and contains more or less non-striped muscular tissue.

The trabecular spaces, above described, are filled with what is called the *pulp* of the spleen. This pulp is a soft reddish-brown substance, and, under the microscope, is found to consist of connective-tissue corpuscles, which, with their communicating processes, make up a fine retiform tissue, the interstices between which are filled with red and white blood-corpuscles. Broadly speaking, then, the spleen pulp is composed chiefly of cells.

The splenic artery enters at the *hilus* of the spleen, by several branches, which ramify in its substance ensheathed and supported by the fibrous framework.* The smallest branches leave the trabeculæ, and, entering the splenic pulp, terminate in minute vessels, arranged in pennicillate tufts. They open, and therefore pour their blood directly, into the pulp tissue. The veins are said to commence in the pulp tissue in the same way as the arteries terminate in it, and to travel along the trabeculæ like the arteries; but they communicate freely, and are so far unlike the arteries.

In the pulp of the spleen we also find what are called the *Malpighian corpuscles*.† They are about $\frac{1}{60}$ of an inch in

* The ramifications of the splenic artery may be seen by washing away the pulp, and floating the flocculent-looking spleen in water.

† It is useless to look for them in the human spleen, unless the subject be ex-

diameter, visible to the naked eye, and look like white spots scattered through the dark pulp. They are attached to the sides of the arteries, and are said to be lymphoid expansions of the connective tissue coat or outside coat of the arteries. These curious spherical bodies are filled with lymph-corpuscles. They appear not to have definite boundaries, but to communicate freely with the reticular spaces of the pulp.

The *lymphatics* of the spleen run between the layers of the gastro-splenic omentum to the lymphatic glands.

The function of the spleen is not yet accurately ascertained. It appears to be, essentially, a great blood-gland; and that it consists of chambers filled with gland-cells of various size, between which ramify minute arteries and veins. It is presumed that the gland elaborates the albuminous materials of food, and stores them up for a time before they pass into the blood. It is considered to be a nursery for the production of the white corpuscles of the blood; and a grave-yard too, where many of the worn-out red ones undergo disintegration.

KIDNEYS.

The kidneys, two in number, are situated in the lumbar region, embedded in fat. Their colour is reddish-brown. Each is about 4 inches in length, and $2\frac{1}{2}$ inches in breadth, and weighs about $4\frac{1}{2}$ ounces in the male, rather less in the female. The left, usually situated higher than the right, is generally longer and somewhat heavier. The anterior surface of each is smooth and convex; the posterior rather flattened. The upper end of the kidney is larger and thicker than the lower; the outer border is rounded; the inner presents a deep notch—the *hilus*—for the entrance and exit of the renal vessels and duct. These have the following relations to one another: in front lies the renal vein; behind is the ureter; between is the renal artery.

The kidney is surrounded by a thin fibrous capsule, to which it is loosely connected by areolar tissue and minute vessels. The

ceedingly fresh, for they soon soften and melt in the pulp. It is better, therefore, to examine them in the spleen of a sheep or bullock, in which animals they are about $\frac{1}{40}$ of an inch in diameter.

capsule does not penetrate into the interior of the kidney, and can be readily stripped off when healthy, leaving the surface perfectly smooth.

FIG. 110.

SECTION OF THE KIDNEY.

1. Ureter.
2. Pelvis of the kidney.
3, 3, 3. Papillæ.

A longitudinal section should be made through the kidney to examine its interior. This section displays two distinct substances, an outer or cortical, and an inner or medullary.

The *medullary* structure is collected into from ten to sixteen pyramidal bundles (pyramids of Malpighi,* fig. 110); the apices of these, termed *papillæ*, project into one of the terminal divisions of the excretory tube. The pyramids are surrounded by the cortical substance which dips down between them; they are composed of minute straight tubes, which proceed from the cortical portion to end on the papillæ.†

The *cortical* structure is deeper in colour than the medullary, forms the outer part of the kidney, and dips down between the pyramids. It consists of convoluted tubes, which become dilated at their extremities into what are called the *Malpighian capsules.*

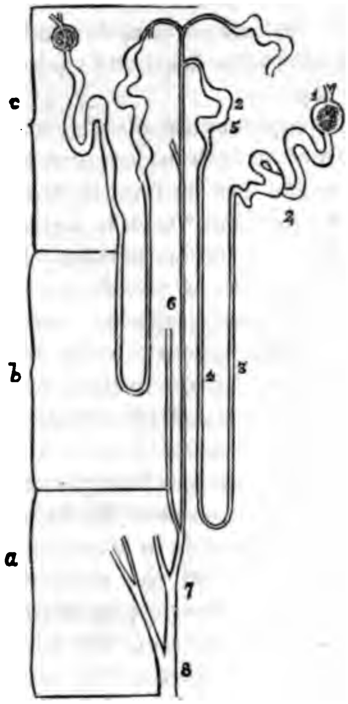
At the *hilus* is the dilated commencement of the ureter, called the *pelvis of the kidney.* It is funnel-shaped, and its broad part divides into two principal channels, which again branch and form

* So named after Malpighi, a celebrated Italian anatomist who lived during the middle and latter part of the seventeenth century.

† Each pyramid represents what was, in the early stage of the kidney's growth, a distinct and independent lobe. In the human subject the lobes gradually coalesce, and no trace of their primordial state remains, except the pyramidal arrangement of the tubes. But in the kidneys of the lower mammalia, of birds and reptiles, the lobes are permanently separate.

from eight to twelve cup-like excavations, called the *calyces*. Into each of these calyces one, sometimes two or more papillæ project. Between the calyces the branches of the renal artery ascend to ramify in the kidney, lying embedded in fat. With a lens, the papillæ may be seen studded with minute apertures, which are

FIG. 111.



1. Malpighian capsule.
2. Convoluted tube.
3. Descending limb.
4. Ascending limb of Henle's loop.
5. Junctional tube.

6, 7. Different portions of straight tube.
8. Excretory tube.
a. Apex of pyramid.
b. Base of pyramid.
c. Cortical portion.

DIAGRAM OF THE COURSE AND ARRANGEMENT OF THE URINIFEROUS TUBES.
(Ludwig.)

the terminations of the uriniferous tubes. These tubes as they pass outwards run straight, bifurcate repeatedly at very acute angles, and reach the sides and the bases of the pyramids. They then enter the cortex in bundles of straight tubes, forming the *pyramids of Ferrein*. They vary from the $\frac{1}{300}$th to the $\frac{1}{600}$th of

an inch in diameter, and are largest towards their termination. On entering the cortex, the tubes become convoluted, and are surrounded by minute plexuses of blood-vessels. The tubuli uriniferi, the pelvis of the kidney, and the ureter, are lined by spheroidal epithelium. Between the straight tubes in the Malpighian pyramids, there have been discovered numerous smaller tubules, named the *looped tubes of Henle*. These come off from the straight tubes in the cortical portion, descend towards the apex of the pyramid, where they form loops, and again ascend to terminate in the Malpighian capsules.

The *Malpighian capsules* are situated in the cortical portion, average about $\frac{1}{130}$th of an inch in diameter, and are visible to the naked eye as minute red points. According to Bowman,* each is formed by the dilatation of the uriniferous tube. It is composed of a homogeneous membrane, and is pierced by a small artery, *afferent* vessel, which enters the capsule opposite to the commencement of the urinary tube. In the capsule the artery breaks up into a coil of minute vessels, *glomerulus*, and returns its blood by a vein (*efferent* vessel), which emerges from the capsule close to where the artery entered (fig. 112). Instead of leaving the kidney, as in other organs, the vein forms a plexus round the convolutions of the urinary tube.† The purpose of this plexus appears to be the secretion of the solid matter of the urine; while the Malpighian body filters the watery part of the urine into the capsule, and washes the more solid part down the tube.‡ The coil of vessels

FIG. 112.

a. Artery.
v. Vein, or efferent vessel.
c. Capsule.
d. Urinary tube.

* 'Philosoph. Trans.' for 1842; part i.

† For a summary of the opinion held by various observers, respecting these Malpighian corpuscles, consult a paper by R. Southey, M.D., 'St. Bartholomew's Hosp. Reports,' vol. i. 1865.

‡ That the vessel leaving the Malpighian body is a vein, and that a constituent part of the urine is secreted by venous blood, is inferred from two reasons: 1. From the analogous case of the vena portæ, out of which the bile is elaborated in the liver; 2. from the fact that in reptiles the urine is secreted from venous blood.

in the capsule is surrounded by the epithelium lining the interior of the capsule.

The renal artery enters the hilus between the pelvis and the renal vein. It shortly divides into four or five branches, which pass outwards between the papillæ, and then enter the cortical portion between the pyramids. In this portion they ascend as far as the bases of the pyramids, and then coursing along their bases they form arches between the cortical and medullary structure, from which small vessels are given off, which pass to the Malpighian capsules.

The nerves forming the renal plexus are derived from the lesser splanchnic nerve and the solar plexus. The lymphatics, consisting of a deep and a superficial set, pass to the lumbar glands.

SUPRA-RENAL CAPSULES. These bodies, situated at the top of the kidneys, belong to the class of ductless glands. The right resembles a cocked hat; the left is more almond-shaped. They measure about $1\frac{1}{4}$ inch in their long diameter, and weigh from one to two drachms. They are surrounded by a thin fibrous covering, which sends down partitions into the interior through furrows upon their surface.

A perpendicular section shows that it consists of a firm exterior or cortical part, and of an interior or medullary substance, soft and pulpy. The *cortical* portion is of a yellow colour, and forms the principal part of the organ. Examined under the microscope, it appears to be composed of a delicate fibrous stroma, in which run parallel columns of cells about $\frac{1}{700}$th of an inch in diameter, arranged perpendicularly to the surface. These columns do not run completely through the thickness of the cortical portion, but have a zone of cells arranged above and below them. The columns are stated by some to be tubes having a distinct lining membrane; by others, to be closed vesicles; by others, to be cavities in the cortical portion. Small arteries are abundantly supplied to the cortex, and dip down between the columns. The *medullary* part varies in colour according to the amount of blood contained in it, being sometimes of a dark-brown colour,

sometimes nearly white. It consists of a plexus of minute veins, among which are numerous cells, some of which appear branched.* The stroma is composed of areolar tissue, which forms a delicate network throughout the central part.

The supra-renal capsules are well supplied with nerves derived from the solar and renal plexuses of the sympathetic. Of late years the minute structure and functions of the supra-renal capsules have been much investigated, in consequence of the discovery, made by Dr. Addison, of the close relation which exists between certain diseases in these bodies and a brown discolouration of the skin. Their precise function is still unknown.

STOMACH AND INTESTINE. The alimentary canal is composed of four coats; a serous, a muscular, a submucous, and a mucous. First, is the *serous* or peritoneal coat, described at p. 379. Secondly, under the serous is a *muscular* coat, upon which the chief strength of the canal depends. It consists of two distinct strata of plain muscular fibres; the outer stratum is longitudinal, the inner circular. This arrangement not only makes the bowel stronger, but regulates its peristaltic action: for the longitudinal fibres, by their contraction, tend to shorten and straighten the tube, while the circular fibres contract upon and propel its contents to greater advantage. Connecting this coat and the mucous, is a layer of areolar tissue called the *submucous coat*, in which the arteries break up before entering the mucous membrane. The *mucous* is the most complicated of all the coats, for it presents different characters in different parts, according to the functions which it has to perform.

STOMACH. The stomach should be moderately distended to see its size, which varies in different subjects according to the habits of the individual. When distended, an average stomach would be about ten or twelve inches in length and four in width. The stomach forms a large bulge to the left of the œsophagus, called the *cardiac* or *splenic* end: on the right side, where the food passes out, it becomes small and con-

* Consult 'A Physiological Essay on the Thymus Gland,' by Simon: London, 1845.

tracted, and is called the *pyloric* end. Just before the pylorus, the stomach bulges into a pouch, called *antrum pylori*. Anatomists describe the stomach as having two borders and two surfaces. The upper border is concave, and called the *lesser curve*: the lower border is convex, and called the *greater curve*. On removing the serous investment of the stomach, the muscular coat is exposed. The fibres are of the non-striped variety, and arranged in three layers, an external or longitudinal, a middle or circular, and an internal or oblique.

The *longitudinal* fibres are continuous with the longitudinal fibres of the œsophagus, and spread out over the stomach: they are most numerous along the curves of the stomach. The *circular* fibres are well marked about the middle of the stomach, but are most abundant at the pylorus, where they form a powerful sphincter. The *oblique* fibres are scattered over the sides of the stomach, and are most distinct at the entrance of the œsophagus, with the well-marked circular fibres of which they are continuous.

When the stomach is laid open, the *mucous membrane* is seen to be of a pale colour, and gathered into longitudinal folds—*rugæ* —which disappear when the stomach is full. The mucous membrane is connected to the muscular layer by a distinct stratum of areolar tissue, called the *submucous coat*. It permits the muscular and mucous coats to move freely on each other, and serves as a bed, in which the blood-vessels ramify minutely before they enter the mucous membrane.

If a portion of the mucous membrane be examined under a microscope, its surface will be seen to be mapped out into small hexagonal pits or *alveoli*, giving it a honey-combed appearance. The pits vary from the $\frac{1}{100}$ to $\frac{1}{200}$ of an inch in diameter. At the bottom of them are a number of minute pores, the orifices of the gastric tubes. In a perpendicular section, the tubes are arranged in parallel lines at right angles to the surface, and terminate in blind sacculated ends set in the submucous tissue. The entire thickness of the mucous membrane is made up of these tubular glands. The tubules are on an average about $\frac{1}{40}$ of an inch long and the $\frac{1}{400}$ of an inch in diameter. In the cardiac end they are

simple tubes, but, at the pyloric, they are frequently branched. Their upper fourth is lined with columnar epithelium; their lower three-fourths, with spheroidal or glandular. It is presumed that these glandular cells contain the gastric juice. As fast as formed, during digestion, they pass into the stomach, discharge their contents, and disappear. Other glands—*pyloric*—are found near the pyloric end of the stomach, and are probably mucous glands. There are also glands more numerous than these, called *peptic glands*. They are lined for a short distance with columnar epithelial cells, which at the neck become spheroidal and granular, and are called *peptic cells*; towards the lower part or fundus of the gland the cells are only found here and there, and cause a more or less bulging of the basement membrane.

The mucous membrane of the stomach is lined by columnar epithelium. It is exceedingly thin and delicate, and can only be seen in the stomach of an animal recently killed.

The tubes of the stomach are richly supplied with blood. The arteries form a stratum of minute inosculations in the submucous tissue, in which the closed ends of the tubes are set; from this stratum the vessels run up between the tubes to the surface of the stomach, where they again inosculate, and form the hexagonal spaces before alluded to.

The stomach is supplied with nerves from the pneumogastric and from the solar plexus.

SMALL INTESTINE. The small intestine, consisting of the duodenum, jejunum, and ileum, forms a tube from sixteen to twenty-six feet in length, according to the height of the individual. The duodenum is about twelve fingers' breadth in length; the jejunum comprises two-fifths, the ileum three-fifths, of the remaining part of the small intestine. As regards their external character, the duodenum and jejunum are more vascular than the ileum, and feel thicker in consequence of the peculiar arrangement of their mucous membrane; but there are no defined limits between the different portions of the intestinal canal. Its peritoneal and muscular coats are the same throughout. The *muscular* coat consists of an outer longitudinal layer and an inner circular thicker

layer, which, however, becomes thinner towards the end of the ileum. It is connected to the mucous membrane by the *submucous* coat. Immediately beneath the mucous membrane there is a very thin layer of non-striped muscular fibre, termed *muscularis mucosæ.*

When the small intestine is cut open from the upper end, we see that the mucous membrane is arranged in close transverse folds, called *valvulæ conniventes.* These differ from other folds in the alimentary canal—*e.g.* in the œsophagus and stomach—in that they are not obliterated when the tube is distended. Each fold extends about one-half or two-thirds round the intestine; but they are not all of equal size. They commence immediately below the opening of the biliary and pancreatic ducts, and are most developed in the duodenum and the upper part of the jejunum. Below this part of the tube they gradually decrease in size, and become wider apart, till they finally disappear near the middle of the ileum. The use of the valvulæ conniventes is to increase the extent of surface for the absorption of chyle; to prevent the food passing too rapidly through the intestine, and for secretion.

If a portion of small intestine be washed and placed in water, the surface of the mucous membrane appears like the soft fur or pile upon velvet. This appearance is produced by small processes called *villi.* These are extremely vascular projections of the mucous membrane, about a fourth of a line in length, and are so numerous that a square line contains from forty to ninety of them.* Their size, however, and their number, bear a direct ratio to that of the valvulæ conniventes. Under the microscope a villus is seen to consist of an outstanding process of the mucous membrane, covered by a layer of columnar epithelium, which rests upon a basement membrane. Each villus is furnished with an artery which forms a network of inosculations in it, and then returns its blood by a single vein. Down its middle runs a *lacteal* or absorbing vessel, which commences in a closed end near the summit of the villus, where it is surrounded by a layer of pale non-striped muscular fibres proceeding from the *muscularis mucosæ.* The

* Krause estimates the total number of villi at four millions.

cylindrical cells which cover the villi are believed to be the agents in the absorption of the chyle, and to possess the power of selection.

INTESTINAL GLANDS. There are four kinds of *glands** in the small intestine, called the glands of Lieberkühn, Brunner, Peyer, and the solitary glands. The first and last are distributed over the whole tract of the intestinal mucous membrane; the other two over particular parts.

The *glands of Lieberkühn*,† the most numerous of all, are minute tubes with blind ends, very thickly distributed over the small and the large intestines. Under the microscope, their orifices are seen between the villi, like so many minute dots. These vary in depth from $\frac{1}{30}$ to $\frac{1}{10}$ of a line, and about the $\frac{1}{50}$ of a line in diameter, and are lined with columnar epithelium.

The *glands of Brunner*‡ are found only in the duodenum. They are just visible to the naked eye, and may be seen by removing the muscular coat. Their structure exactly resembles the round compound glands of the mucous membrane of the mouth.

The *glands of Peyer* § (glandulæ agminatæ) abound most in the ileum, and are seen most distinctly in children. They are arranged in groups, from twenty to forty in number, on that part of the intestine most distant from the attachment of the mesentery. These groups are from half an inch to three inches long, of an oval form, and increase in size and number towards the lower part of the ileum. If a group be examined by dissecting away the muscular coat, you find that it is composed of a number of small oval vesicles, like Florence flasks, embedded in the sub-mucous tissue. They are composed of masses of lymphoid tissue, of about three-fourths of a line in diameter, and contain an opaque greyish fluid. No excretory ducts have been traced from these vesicles, but they are supposed to discharge their contents by rupture of

* A satisfactory examination of the intestinal glands can be made only in specimens quite recent, taken from young persons who have died suddenly, or from a rapidly fatal disease.

† J. N. Lieberkühn, 'Diss. de fabric. et actione villorum intestin. ten.,' 1782.

‡ J. C. Brunner, 'Gland. duoden. seu pancreas secundarium,' 1715.

§ Peyer, 'De glandulis intestinorum,' 1682. These glands were first described by Nehemiah Grew, in 1681.

their capsules. Between the vesicles are found Lieberkühn's follicles; and the surface of the patches is covered with villi. These glands are liable to be ulcerated in typhoid fever. They diminish in number and size with old age.

The *solitary glands* are scattered over all parts of the small and large intestines. They consist of the same lymphoid structure as the glands of Peyer, and only differ from them in being solitary instead of being aggregated into groups.

The *lymphatics* consist of two sets, those of the muscular and those of the mucous coats; the latter receive those from the villi, at the base of which they form a minute plexus, and, after piercing the muscular coat, join with the former, which are chiefly found between the longitudinal and the circular layers of muscular fibres.

The *nerves* are derived from the superior mesenteric plexus, and accompany the superior mesenteric artery and its branches, between the layers of the mesentery; after reaching the intestinal walls the nerve-filaments separate from the arteries. They then pierce the external longitudinal muscular fibres and form a very minute gangliated plexus, *Auerbach's plexus* or *plexus myentericus*, which distributes filaments to the muscular layer of the entire intestinal canal. From this plexus numerous branches perforate the internal circular muscular layer, and unite to form a largely gangliated plexus, *Meissner's plexus*, in the submucous tissue. The intermuscular plexus probably supplies the muscular coat and regulates the peristaltic action of the bowel; the *submucous plexus* determines the calibre of the blood-vessels.

LARGE INTESTINE. The principal external characters of the large intestine are that it is pouched or sacculated, and that it has attached to it little pendulous portions of fat covered by peritoneum, called *appendices epiploicæ*. The pouches (sacculi) are produced by a shortening of the longitudinal muscular fibres, and by their being collected into three bands, about half an inch wide, nearly equidistant from each other. One of these bands corresponds with the attached part of the circumference of the bowel; another with the front part; a third with its concavity. If

at any given part the three bands be divided, the pouches immediately disappear.

In a colon moderately distended and dried, we observe that the mucous membrane forms numerous ridges or incomplete septa (see fig. 113): they correspond to the grooves on the external surface of the bowel, and disappear, like the sacculi, when the longitudinal bands are divided.

The *rectum* differs from the rest of the large intestine in that its longitudinal muscular fibres are not collected into bands, but

FIG. 113.

1. Ileum.
2. Cæcum or caput coli.
3. Appendix vermiformis.

SECTION THROUGH THE JUNCTION OF THE LARGE AND SMALL INTESTINE, TO SHOW THE ILIO-CÆCAL VALVE.

distributed equally over its whole circumference. Moreover, both the longitudinal and circular fibres are of considerable strength, like those of the œsophagus, as one might expect from the particular functions which these parts of the alimentary canal have to perform. For an inch and a half, or thereabouts, above the anus, the circular fibres are remarkably developed, and constitute the internal *sphincter ani.*

The mucous membrane of the large intestine differs considerably from that of the small. There are neither valvulæ conni-

ventes nor villi; but the glands of Lieberkühn and the lymphoid follicles may be seen studding the mucous membrane. The follicles are more abundant in the cæcum and in the appendix vermiformis than in any other part of the alimentary canal. The blood-vessels present the same hexagonal arrangement on the surface as that of the stomach. That the mucous membrane of the large intestine may be temporarily used as a substitute for the stomach is proved by the fact of persons having been nourished for many weeks solely by injections. The mucous membrane is lined throughout with columnar epithelium.

Ilio-cæcal Valve. At the junction of the small with the large intestine the mucous membrane is folded so as to form a valve: but it is not a perfect one, as is proved by pouring water into the large intestine, or by the occasional vomiting of injections. The arrangement of the valve is best examined in a dried preparation. The opening is a transverse fissure like a button-hole; and the two flaps are arranged like an upper and a lower eyelid. The upper lid of the valve projects more than the lower, so that the contents of the ileum drop naturally down into the caput coli, where they are apt to collect and form hard lumps. The flaps of the valve consist of mucous membrane and the circular fibres of the ileum. The longitudinal fibres of the ileum are continued directly on to the cæcum: if these be divided, the ileum can be drawn out, and the valve disappears.*

Folds in the Rectum. In many subjects we observe that transverse or oblique folds of the mucous membrane project into the rectum. These cannot be seen to advantage unless the bowel be hardened by alcohol in its natural position. Three, more prominent than the rest, and half an inch, or thereabouts, in width, were first pointed out by Mr. Houston.† One projects from the upper part of the rectum, opposite the prostate gland; another is situated higher up, on the side of the bowel; while the third is still higher. When thickened or ulcerated, these folds are apt to occasion great pain and obstruction in defæcation.

* It is interesting to note that the surface of the valve, towards the ileum, covered with villi; not so the surface towards the large intestine.

† 'Dublin Hospital Reports,' vol. v.

DISSECTION OF THE LOWER EXTREMITY.

The body having been placed on its back, the thigh should be slightly flexed and abducted. An incision should be made along the groin, from the anterior superior spine of the ilium to the spine of the pubes; another, from the middle of the first, down the thigh for about six inches. The skin being reflected, the superficial fascia and vessels will be exposed.

Superficial Fascia. This fascia varies in thickness, according to the condition of the body. Like other superficial fasciæ, it is divisible into two layers, between which are situated the inguinal glands, and the cutaneous vessels. The upper layer is continuous with that of the abdomen; the deeper layer is best marked in the upper part of the thigh, especially where it stretches across the saphenous opening to form the *cribriform fascia*, and is attached to Poupart's ligament.

The cutaneous vessels come from the femoral artery and are three in number, the *superficial epigastric*, the *superficial external pudic*, and the *superficial circumflexa ilii* arteries: the first ascends over Poupart's ligament to the abdomen (p. 355); the second crosses inwards towards the pubes; and the third passes outwards to the ilium. Each artery is accompanied by one, sometimes by two veins, which empty themselves, either directly into the femoral, or into the great cutaneous vein of the thigh, called the saphena.

Superficial Inguinal Glands. These glands are easily recognised, by their oval form and reddish-brown colour. There are two sets: one set runs parallel to Poupart's ligament, and receives the lymphatics from the penis, the scrotum, the perineum, the anus, the buttock, the lower part of the ab-

dominal wall, and the upper and outer aspect of the thigh; the other set lies along the saphena vein, and receives the lymphatics from the foot, the leg, and the lower part of the thigh. This explains why in cancer of the scrotum and syphilitic disease of the penis the first set becomes enlarged; and the second, in diseases of the lower extremity. The lymphatic vessels which pass to and from the glands are small, and may escape observation, unless specially looked for. They all pass through the femoral ring into the abdomen, and eventually empty themselves into the receptaculum chyli.

The glands mentioned in the preceding paragraph are all superficial. There are others, more deeply seated, close to the great vessels of the thigh: these are much smaller, and sometimes cannot be found.

SUPERFICIAL ARTERIES OF THE GROIN.

The *superficial epigastric* artery comes through the fascia lata, half an inch below Poupart's ligament, supplies the inguinal glands, and anastomoses with the deep epigastric artery. Its further course is described at p. 355.

The *superficial circumflexa ilii* runs parallel to Poupart's ligament towards the crest of the ilium, and ends in the skin and subcutaneous tissue.

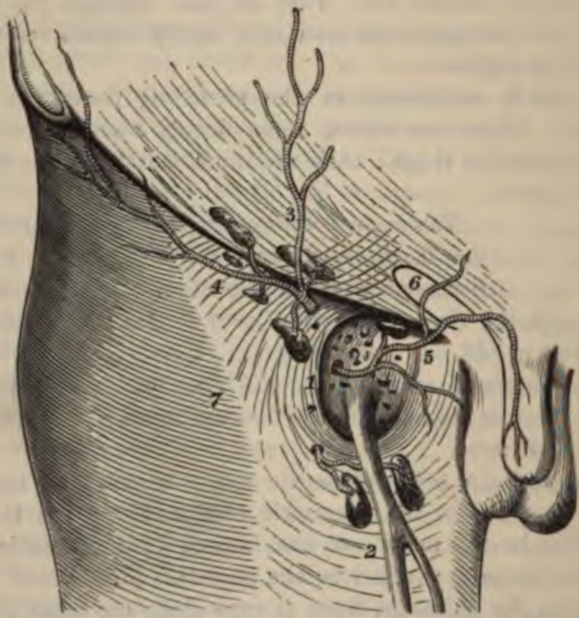
The *superficial external pudic* comes through the saphenous opening, crosses over the spermatic cord, and supplies the penis and scrotum in the male, and the labium in the female. This artery is liable to be divided in the operation for femoral hernia; also in that for phimosis, since it runs along the penis to supply the prepuce. Arising directly from so large an artery as the femoral, it sometimes bleeds profusely; for it is an admitted fact that when even a small branch, coming directly from a principal artery, is divided near its origin, it will sometimes pour out as much blood as if an opening were punched out of the trunk as large as the area of the divided branch.* There is another pudic artery, called the *deep or inferior external pudic*:

* Mr. Liston had occasion to tie the external iliac artery for a supposed injury (by a pistol-ball) to the femoral. It was discovered, after the death of the patient, that

this runs between the fascia lata and the pectineus, supplying that muscle, the scrotum in the male, and the labium in the female.

The incision should be prolonged down the thigh, over the knee to the tubercle of the tibia. The skin must then be reflected, to expose the subcutaneous tissue over the whole of the

Fig. 114.



SUPERFICIAL VESSELS AND GLANDS OF THE GROIN. SAPHENOUS OPENING WITH THE CRIBRIFORM FASCIA.

1. Saphenous opening of the fascia lata.
2. Saphena vein.
3. Superficial epigastric artery.
4. Superficial circumflexa ilii artery.
5. Superficial pudic artery.
6. External abdominal ring.
7. Fascia lata of the thigh.

front of the thigh. In it will be found the cutaneous vessels and nerves, which must be carefully dissected.

the ball had injured only one of the superficial branches of the femoral, about an inch from its origin. See his paper in the 'Med.-Chir. Trans.' vol. xxix. 1846.

SAPHENA VEIN. This is the chief subcutaneous vein of the lower limb. Its roots, arising on the inner side of the foot, unite into a single trunk, which ascends in front of the inner ankle, along the inner side of the leg, behind the knee, along the inner and front part of the thigh, where it passes through an opening—the *saphenous opening*— in the fascia lata, to join the femoral vein, immediately below the crural arch (fig. 114). In this long course it receives several tributary veins, some of which are often large; and, just before its termination, it is joined by the superficial veins which accompany the arteries of the groin already alluded to (p. 497). Like all subcutaneous veins, it is provided at intervals with valves, chiefly where joined by other veins, to support the column of the blood.

CUTANEOUS NERVES. The distribution of the cutaneous nerves of the thigh varies considerably, but they are always found more abundantly on the inner than on the outer aspect of the thigh. The nerves are divided into *external*, *middle*, and *internal*. All directly or indirectly proceed from the lumbar plexus, and, perforating the fascia, divide in the subcutaneous tissue.

a. The *external cutaneous nerve* is a branch of the second lumbar nerve. It enters the thigh beneath Poupart's ligament close to the anterior superior spine of the ilium. Here it divides into two branches, an anterior and a posterior. The *anterior* branch comes through the fascia lata about four inches below Poupart's ligament and can be traced down the outer side of the thigh as far as the knee, giving off numerous branches. The *posterior* branch, after coming through the fascia, divides into filaments, which are distributed to the skin over the nates and the posterior part of the thigh.

b. The *middle cutaneous nerves*, one or two in number, are given off by the anterior crural. They pass through the sartorius about four inches below Poupart's ligament, perforate the fascia lata, and descend along the front and inner part of the thigh as far as the knee, distributing branches on either side; some of which communicate with the long saphenous nerve. In its course

along the front of the thigh it joins with the crural branch of the genito-crural and the internal cutaneous nerves.

c. The *internal cutaneous nerve*, also a branch of the anterior crural, crosses obliquely over the femoral artery. It then divides into branches which perforate the fascia lata, and supply the skin on the inner side of the thigh, over the patella, and the inner side of the leg. Some of these communicate with the middle cutaneous, the long saphenous and the cutaneous branch of the obturator.*

d. The *crural branch* of the *genito-crural nerve* perforates the fascia external to the femoral artery, immediately below Poupart's ligament, and supplies the skin in front of the thigh. About two or three inches below the crural arch it usually communicates with the middle cutaneous nerve. It also distributes a few filaments to the femoral artery in its passage under the crural arch.

e. The *ilio-inguinal nerve*, after emerging from the external abdominal ring, supplies the skin on the inner aspect of the thigh.

FASCIA LATA.

Remove the subcutaneous fat to examine the *fascia lata* of the thigh. The use of this fascia is to cover the muscles of the thigh collectively, and to form separate sheaths for each; so that it not only keeps them together, but maintains each in its proper position. A knowledge of these sheaths is important, because they interfere with the progress of deep-seated matter towards the surface, and cause it to burrow in this or that direction according to the part in which it forms.

The fascia is not of equal strength all round the thigh. It is comparatively thin on the inner side; exceedingly thick and strong down the outer side; here, indeed, it has the appearance of a dense expanded aponeurosis, strapping down the vastus externus muscle; and it certainly performs the office of a tendon, for it gives insertion to two powerful muscles—namely, the tensor fasciæ femoris, and the gluteus maximus (fig. 115).

The fascia lata is attached to the margin of the bones which constitute the framework of the lower extremity. Beginning from

* It is important to note that one, or sometimes two, of these internal cutaneous nerves cross the sheath of the femoral artery just where the sartorius begins to overlap it; and therefore at the spot where it is usually tied. See diag., p. 511.

above, its attachment can be traced from the posterior surface of the sacrum and coccyx, along the crest of the ilium, thence along the crural arch to the body of the pubes, and down the rami of the pubes and ischium. Proceeding down the thigh, it penetrates, on either side of the limb, to the linea aspera, forming what are called the *external* and *internal intermuscular septa*, which separate the extensor from the flexor muscles. Below, it can be traced round the knee-joint, and is particularly strong, especially on the outer side, where it is attached to the head of the tibia and fibula, and forms the insertion of the tensor fasciæ femoris.

Fig. 115.

FASCIA ON THE OUTSIDE OF THE THIGH.

1. Tensor fasciæ femoris.
2. Gluteus maximus.
3. Lower fibres of ditto.
4. Fascia lata.

There are numerous small apertures in the fascia, through which the cutaneous nerves and vessels are transmitted; but the most important one is the large opening—the *saphenous opening*—through which the saphena vein passes to join the femoral. That part of the fascia lata situated external to the saphenous opening is termed the *iliac* portion of the fascia lata; that internal to it, the *pubic* portion.

SAPHENOUS OPENING IN THE FASCIA LATA.

The saphenous opening is an oval aperture in the fascia lata, immediately below the crural arch, on the inner side of the front of the thigh, through which the saphena vein passes to join the femoral. There is no definite border to the saphenous opening until the fascia, which covers the opening and blends with its margin, has been removed. The term *cribriform* has been given to this fascia, because it is perforated with holes for the passage of the superficial vessels and lymphatics. It is a thin covering over the saphenous opening, and is prolonged from the outer edge of the opening over the sheath of the femoral vessels, and adheres on the inner side to the fascia lata, over the pectineus muscle.

CRIBRIFORM FASCIA.

Some anatomists describe this fascia as a portion of the superficial fascia; others consider it as a thin prolongation of the fascia lata itself across the opening. Its chief surgical importance is derived from the fact that it forms one of the coverings of a femoral hernia.

The cribriform fascia must now be removed so as to display the saphenous opening, which will appear as represented in fig. 116.

Reverting to the saphenous opening, we observe that it is situated just below the crural arch, not far from the pubes; that it is oval with the long axis vertical, and about one inch and a half

Fig. 116.

1. Crural arch.
Saphenous opening of the fascia lata.
Saphena vein.
4. Femoral vein.

5. Gimbernat's ligament.
6. External abdominal ring.
7. Position of the internal ring in dotted outline.

DIAGRAM OF THE FEMORAL RING AND THE SAPHENOUS OPENING.
(The arrow is introduced into the femoral ring.)

long and an inch broad. Its border on the inner side is not defined; for here the fascia lata ascends under the femoral vessels, and is continuous with the iliac fascia of the pelvis.* But the outer or iliac border is clearly defined. This lies in front of the femoral vessels, is crescent-shaped, with the concavity towards the pubes, and called the *falciform process of Burns*. The lower horn of the crescent curves under the saphena vein with a well-defined border, and on being traced upwards becomes less well

* On the inner side of the femoral vessels the pubic portion of the fascia is attached to the linea ilio-pectinea.

marked until it is gradually lost in the fascia on the inner side of the opening. The upper horn, *Hey's ligament,** arches over the femoral vein, and then descending slightly is continued uninterruptedly into Gimbernat's ligament—*i.e.* into that part of the crural arch which is inserted into the linea ilio-pectinea. The upper horn deserves especial attention, because it forms the upper boundary of the aperture through which a femoral hernia takes place; and, being chiefly concerned in the constriction of the rupture, must be divided for its relief. This may be easily ascertained by introducing the little finger under the crural arch, on the inner side of the femoral vein—in other words, into the femoral ring (see the arrow in the diagram). Feel how the upper horn of the crescent would girt the neck of a hernia, and that its tension is greatly influenced by the position of the limb; for if the thigh be bent and brought over to the other side, the tension of all the parts is materially lessened.†

ANATOMY OF THE PARTS CONCERNED IN FEMORAL HERNIA.

The anatomy of the parts concerned in femoral hernia cannot be thoroughly understood without the assistance of special dissections. The following demonstration, therefore, takes for granted that the student has the opportunity of seeing the parts, not only on their femoral, but also on their abdominal side.

The different parts of the subject should be examined in the following order:—

a. The formation of the crural arch.

b. The arrangement of the parts as they pass under the arch.

c. The sheath of the femoral vessels.

* This upper horn is sometimes called 'Hey's ligament,' after the surgeon who first drew attention to it: 'Observations in Surgery,' by W. Hey, F.R.S. London, 1810.

† We must always bear in mind that, though the crural arch and the fascia attached to it have received particular names, they are not, on that account, distinct and separate; but all are intimately connected, and portions merely of one continuous expansion. Thus all the parts are kept in a condition of mutual tension, which depends very much on the position of the thigh.

d. The crural canal and ring.

e. The practical application of the subject.

POUPART'S LIGAMENT OR CRURAL ARCH. The lower border of the aponeurosis of the external oblique muscle extends from the anterior superior spine of the ilium to the spine of the pubes, and forms, over the bony excavation beneath, the *crural arch* or *Poupart's ligament*. (It is marked by the dark line in fig. 116.) The direction of the arch is at first somewhat oblique, but towards its inner half, becomes nearly horizontal. In consequence of its intimate connection with the muscular fascia of the thigh, the line of the arch describes a gentle curve with the convexity downwards. The arch is attached to the spine of the pubes, and also for some distance along the linea ilio-pectinea (fig. 116). This additional attachment, called *Gimbernat's ligament*,* is of importance, for it is frequently the seat of stricture in femoral hernia.

GIMBERNAT'S LIGAMENT. The best view of Gimbernat's ligament is obtained from within the abdomen; it being only necessary to remove the peritoneum. It is placed nearly horizontally, in the erect posture, and is triangular with its apex at the pubes and its base directed outwards. In front, it is continuous with the crural arch; behind, it is inserted into the linea ilio-pectinea; externally, it is continuous with the fascia lata through Hey's ligament (fig. 116). Its length is from $\frac{3}{4}$ of an inch to 1 inch; but it is usually longer in the male than the female.

On putting your finger into the femoral ring, you feel the sharp and wiry edge of this ligament: observe, too, that as the body lies on the table, the plane of the ligament is perpendicular, and therefore that it *recedes from the surface.*

ARRANGEMENT OF THE PARTS WHICH PASS UNDER THE ARCH. The crural arch transmits from the abdomen into the thigh (proceeding in order from the outer side) the following objects, shown in fig. 117): 1. The external cutaneous nerve; 2. The iliacus and psoas muscles, with the anterior crural nerve between them;

* Don Antonio de Gimbernat was a Spanish surgeon, who published, in 1793, 'A new Method of Operating for the Femoral Hernia.' Madrid.

3. The femoral artery and vein with the crural branch of the genito-crural nerve. These muscles and vessels fill up the space beneath the crural arch, except on the inner side of the femoral vein, where a space is left for the passage of the lymphatics: this is called the *crural* or *femoral ring*. The muscles are separated from the vessels by a strong vertical fibrous partition passing from the arch to the bone, which is nothing more than a continuation of the sheath of the psoas. The artery, too, is separated from the vein by a similar, although a much weaker partition, and there is

FIG. 117.

POSITION OF PARTS UNDER THE CRURAL ARCH (VERTICAL SECTION).

a third close to the inner side of the vein. These three partitions not only keep all the parts in their right place, but confine the arch down to the bone, and prevent its being uplifted by any protrusion between it and the muscles and vessels. This, coupled with the close attachment of the fascia iliaca to the crural arch, explains why a femoral hernia rarely takes place in any other situation than on the inner side of the femoral vein.*

* If the partitions from any cause yield, or become slack, then a rupture may descend in front of the vessels, or even (though this is rare) on the outer side of the artery.

SHEATH OF THE FEMORAL VESSELS. The femoral vessels descend beneath the crural arch, enclosed in a funnel-shaped membranous sheath. This sheath appears to be derived immediately from the arch itself, but it is really formed, *in front*, by a prolongation from the fascia transversalis of the abdomen. This prolongation, uniting with the continuation from the fascia iliaca to join the fascia lata *behind* the femoral vessels, forms a funnel, with the wide part uppermost, into which the femoral vessels enter. This is the funnel-shaped sheath of the femoral vessels.

FIG. 118.

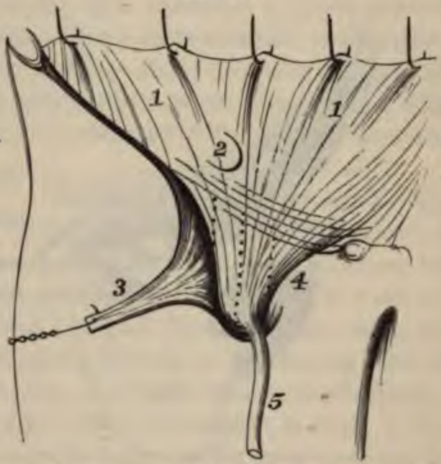


DIAGRAM OF THE SHEATH OF THE FEMORAL VESSELS.

To examine this sheath satisfactorily, it is necessary to reflect, from its attachment to the crural arch, the upper horn of the saphenous opening, as shown in fig. 118. By this proceeding, we expose the fascia transversalis descending over the femoral vessels, and forming the front part of their sheath. The hind part of the sheath is formed by the fascia iliaca, which runs down behind the vessels to join the pubic portion of the fascia lata. The sheath descends as low as the lower horn of the saphenous opening, where it is gradually lost upon the ordinary fibrous investment of the femoral vessels. The outer part of the sheath

is perforated by the crural branch of the genito-crural nerve, and the superficial arteries of the groin; the inner part, by the saphena vein and some lymphatic vessels.

The sheath of the femoral vessels is divided into three compartments separated from each other by partitions: the outer is occupied by the femoral artery; the middle, by the femoral vein; the inner is the crural canal, into which the femoral hernia descends.

Practically, the sheath is important for many reasons:—

1. A femoral hernia descends within it. 2. It constitutes, therefore, one of the coverings, *fascia propria*, of the hernia. 3. It contains in its substance bands of fibres, *deep crural arch*, running in the same direction as the crural arch, but quite independent of it, as shown in fig. 118; these bands lie over the neck of the sac, and are often the seat of the stricture; it is therefore necessary to divide them before the intestine can be returned.

CRURAL CANAL AND FEMORAL RING.

The hollow under the crural arch is completely occupied by the structures before mentioned, except for a small space, called the *crural canal*, on the inner side of the vein. This canal is from a quarter to half an inch in length. It commences, above, in the femoral ring; and ends, below, at the saphenous opening. The *femoral ring* is the upper opening of the crural canal, and is bounded, *in front*, by the crural arch; *behind*, by the bone; on the *outer side*, by the femoral vein; on the *inner side*, by the thin, wiry edge of Gimbernat's ligament. In the undisturbed condition of the parts there is no gap; it is only a weak place, which, when a hernia escapes through it, feels like a ring: hence the name of *femoral ring.**

The femoral ring is surrounded on all sides by unyielding structures. This accounts for the little benefit afforded by the warm bath in cases of strangulation. Sir W. Lawrence was in

* The femoral ring is naturally occupied by a little fat and cellular membrane, by lymphatic vessels, and often by a small lymphatic gland. But we have never met with anything deserving the name of a 'diaphragm' or membranous septum, such as is described by Cloquet as the 'septum crurale,' and is, surgically, of no importance.

the habit of saying that he never saw a strangulated femoral hernia where the warm bath was of any avail.

PRACTICAL APPLICATION OF THE SUBJECT.

From what has been said, the student ought now to understand—1, at what aperture a femoral hernia escapes from the abdomen; 2, the course which it takes, and its relations to the surrounding parts; 3, the proper mode of attempting the reduction; 4, the structure and arrangement of its coverings; and, lastly, the probable seat of stricture.

The hernia escapes from the abdomen through the femoral ring—that is, under the weak part of the crural arch, between the femoral vein and Gimbernat's ligament. Here is the mouth of the hernial sac, or that part of it which communicates with the abdomen. It descends for a short distance nearly perpendicularly, and projects as a small tumour in front of the pectineus muscle. Its progress downwards, however, is soon arrested, partly by the very close adhesion of the subcutaneous structures to the lower margin of the saphenous opening; partly by the flexion of the thigh. Consequently, if the hernia increase in size, it must rise over the crural arch, where the subcutaneous tissue offers less resistance; and the bulk of the hernia extends outwards towards the ilium, assuming more or less of an oblong form, with the long axis parallel to the crural arch. Since, then, the body of the hernia forms a very acute angle with the neck, the right mode of attempting its reduction is, to draw it, first, down from the groin, and then to make pressure on it, backwards, in the direction of the femoral ring.

COVERINGS OF A FEMORAL HERNIA.

The *coverings* of a femoral hernia are as follows:—It first protrudes before it the *peritoneum*, technically called the hernial sac.* The sac is covered by more or less fat, according to the condition of the patient, called the *sub-peritoneal fat*. It next pushes before it the sheath of the femoral vessels, which forms an investment

* In some cases the fascia propria so much resembles the hernial sac, that it is not easy to distinguish between them. Generally speaking they are separated by a small quantity of fat.

called the *fascia propria.* In front of this is the *cribriform fascia.* Lastly, there is the *subcutaneous tissue* and *skin.*

SEAT OF STRICTURE. The *seat of stricture* is usually at the femoral ring, and the position of the neighbouring blood-vessels indicates that the proper direction in which to divide the stricture is, either directly inwards, through Gimbernat's ligament, as recommended by Sir W. Lawrence, or upwards through Hey's ligament, as recommended by Sir A. Cooper.* There is no risk of wounding an artery, supposing the vessels to take their ordinary course. But it occasionally happens (p. 441), that the obturator artery runs *above* (in the recumbent position) the femoral ring; in such a case, the neck of the sac would be encircled by a large blood-vessel.† From the examination of two hundred bodies, the chances are about seventy to one against this unfavourable distribution. But the possibility of it has given rise to *this rule* in practice—not to cut deeply in any one place through the stricture, but rather to notch it in several. By this proceeding we are much less likely to wound the abnormal artery, because it does not run at the base of Gimbernat's ligament, but about a line and a half from the margin of it.‡

Such is an outline of the anatomy of the parts concerned in a femoral hernia. The normal anatomy in each case being similar, it might be supposed that all operations for the relief of this kind of hernia would be straightforward and pretty much alike; but this is very far from being the case: indeed, surgeons agree that they never operate without the expectation of meeting some peculiarity.

* The operation recommended by Sir A. Cooper is that usually performed now; because, if Gimbernat's ligament be divided, its cut edges often retract to such an extent, that no truss can possibly retain the hernia when the patient assumes the erect posture.

† The museum of St. Bartholomew's Hospital contains two examples of double femoral herniæ in the male, with the obturator arising on each side from the epigastric. In three out of the four herniæ the obturator runs on the inner side of the mouth of the sac. See Prep. 55, 69, Series 17.

‡ During the session of 1867–68 more than half a dozen instances occurred where the obturator artery was given off by a common origin with the epigastric artery. In

DISSECTION. The fascia must now be removed from the front of the thigh, without disturbing the subjacent muscles from their relative positions. The mass of muscles, on the inner side of the thigh, consists of the adductors; that in the middle, of the extensors: the long thin muscle crossing obliquely in front from the outer to the inner side, is the sartorius. In the middle are seen the femoral vessels, and the anterior crural nerve emerging beneath the crural arch.

SARTORIUS. This muscle *arises* from the anterior superior spine of the ilium, and from the ridge below to the extent of an inch. It passes obliquely like a strap over the front of the thigh towards the inner side; and then descends almost perpendicularly on the inner side of the thigh as far as the knee, where it terminates in a flat tendon which expands, and is *inserted* into the inner and front part of the tibia just below its tubercle. The tendon appears all the wider on account of its broad connection with the fascia of the leg, which extends as low as the internal malleolus. The broad insertion of this muscle lies anterior to and covers the tendinous insertions of the gracilis and semi-tendinosus, and between them is a bursa. A large bursa* is interposed between the tendon and the internal lateral ligament. The chief *action* of the muscle is to fix the pelvis steadily on the thigh.† It crosses one leg over the other, as tailors sit when at work. Its nerve comes from the middle cutaneous branch of the anterior crural.

SCARPA'S TRIANGLE. In consequence of the oblique direction of the upper third of the sartorius, a triangle is formed, which has this muscle and the adductor longus for its two sides, and the crural arch for its base: the triangle is called *Scarpa's*.‡

all these cases, however, the artery passed close by the bone, that is *behind* the sac, so that it would not have been injured in the operation for relief of strangulation.

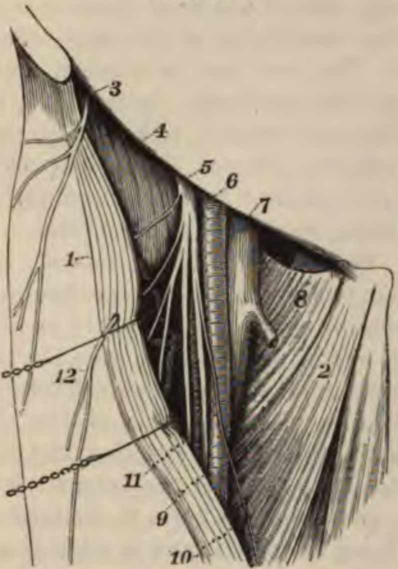
* In persons, females especially, who are in the habit of riding, this bursa sometimes becomes enlarged.

† Hence the name given to it by Spigelius (De corporis hum. fabric.), 'Quem ego sartorium musculum vocare soleo, quod sartores eo maximè utuntur, dum crus cruri inter consuendum imponunt.'

‡ So called in compliment to the Italian anatomist who first tied the femoral in it for popliteal aneurysm.

The contents of this important space should be carefully displayed, and their relative positions well studied. This triangle contains all the parts which pass under the crural arch: namely, from without inwards, the external cutaneous nerve, close to the anterior spine of the ilium; the iliacus internus and psoas; the anterior crural nerve and its divisions, especially the long saphenous nerve; the common femoral artery with its two large divisions, the superficial femoral and the profunda, which run

FIG. 119.



1. Sartorius.
2. Adductor longus.
3. External cutaneous n.
4. Iliacus internus.
5. Anterior crural n.
6. Femoral artery.
7. Femoral vein.
8. Pectineus.
9. Long saphenous n.
10. Internal cutaneous n.
11. Nerve to vastus internus.
12. Middle cutaneous n.

DIAGRAM OF SCARPA'S TRIANGLE.

down nearly parallel to each other, the latter giving off the internal and external circumflex; the femoral vein, joined by the profunda vein and the internal saphena, and the pectineus muscle with the deep external pudic artery.

The triangle is important in a surgical point of view, since it is in this space that the femoral artery is usually ligatured for popliteal aneurysm. The guide to the artery is the inner border of the sartorius. The situation at which this muscle crosses over

the femoral artery, varies from one and a half to four and a half inches below Poupart's ligament; so that no rule can be laid down as to the exact situation where the artery disappears beneath the sartorius. The best way to find the inner border of the muscle during life, is to make the patient put it in action.

ADDUCTOR MUSCLES. A strong group of muscles, called the *adductors*, extends along the inner side of the thigh, from the pelvis to the femur. Their two most important actions are to co-operate in balancing the pelvis steadily on the thigh, as in standing on one leg; and (if the fixed point be reversed) to draw together or adduct the thighs, at the same time rotating the thigh externally. They are five in number, and are supplied, with one exception—the pectineus—by the same nerve—namely, the obturator. They are termed, respectively, the gracilis, adductor longus, pectineus, adductor brevis, and adductor magnus. The innermost is the gracilis; to clean it properly, it should be stretched by separating one thigh from the other.

GRACILIS. This long, flat muscle *arises* by a broad, ribbon-like tendon from the pubes close to the symphysis, and from the border of the pubic arch nearly as low as the tuber ischii. It descends almost perpendicularly on the inner side of the thigh, and terminates in a round tendon which subsequently spreads out, and is *inserted* into the inner side of the tibia below the tubercle, immediately behind the sartorius and above the semi-tendinous. The tendon plays over the internal lateral ligament of the knee-joint, and there is a bursa to diminish friction. This muscle assists in fixing the pelvis, and in adducting the thigh; it further helps to bend the knee. Its nerve comes from the anterior division of the obturator.

ADDUCTOR LONGUS. This triangular muscle lies between the gracilis, and the pectineus, and *arises* by a round tendon from the front of the body of the pubes below the crest. As it descends, the muscle becomes broader, and is *inserted* into the middle third of the inner margin of the linea aspera of the femur. It forms with the sartorius the triangular space called Scarpa's triangle, above described. It rests upon the adductor brevis and

magnus, the profunda vessels and the obturator nerve. It is supplied by the anterior division of the obturator nerve.

PECTINEUS. This muscle lies on the same plane, but external to the adductor longus, from which it is separated by a slight interval, in which may be seen the anterior division of the obturator nerve. It *arises* from the triangular surface of the pubes in front of the linea ilio-pectinea, and is *inserted* into the upper part of the ridge leading from the lesser trochanter to the linea aspera. It lies upon the adductor brevis, the obturator vessels and nerve and the obturator externus. Its nerve comes from the anterior crural, sometimes also from the obturator (p. 410).

By separating the contiguous borders of the pectineus and the adductor longus, the adductor brevis is exposed with the anterior division of the obturator nerve lying upon it. To obtain a complete view of it, the pectineus and adductor longus must be reflected from their origins. The obturator nerve supplies all the adductors. It leaves the pelvis through the upper part of the obturator foramen, and soon divides into an anterior and posterior branch: the *anterior* runs in front of the adductor brevis, and supplies the hip-joint, the adductor longus, the gracilis, and sometimes the adductor brevis and the pectineus; the *posterior* runs behind the adductor brevis, and supplies it as well as the obturator externus, the adductor magnus, and the knee-joint.

ADDUCTOR BREVIS. This muscle *arises* from the front surface of the body of the pubes near the symphysis, and from its descending ramus for about an inch; it widens as it descends, and is *inserted* behind the pectineus into the whole length of the ridge leading from the lesser trochanter to the linea aspera. Behind, it rests upon the posterior division of the obturator nerve, and the adductor magnus. Its nerve is derived from the obturator. By reflecting it from its origin, the following muscle is exposed.*

* Beneath the adductor brevis, and running parallel with the upper border of the adductor magnus, is seen the obturator externus. But the description of this muscle is deferred till the dissection of the external rotators of the thigh.

ADDUCTOR MAGNUS. This muscle *arises* from the lower part of the body of the pubes near the symphysis, from the rami of the pubes and ischium, and from the tuberosity of the ischium. Its fibres spread out, and are *inserted*, behind the other adductors, into the lower part of the linea quadrati, into the ridge leading from the great trochanter to the linea aspera, also into the whole length of the linea aspera, and the ridge leading from it to the inner condyle. The upper fibres pass transversely outwards to their insertion, while the lower fibres descend nearly vertically. In front of the muscle are the adductor longus and brevis, the vastus internus, the obturator nerve and artery and the profunda artery; above it are the internal circumflex artery, the obturator externus, and the quadratus femoris; behind it, the biceps, semi-tendinous and semi-membranosus, the great ischiatic nerve, and the gluteus maximus. Its nerve comes from the posterior division of the obturator. Observe that all the adductor muscles are inserted into the femur by flat tendons more or less connected.

About the junction of the upper two-thirds with the lower third of the thigh, the femoral artery passes through an oval opening in the tendon of the adductor magnus.

PSOAS MAGNUS AND ILIACUS INTERNUS. These muscles have been fully described in the dissection of the abdomen (p. 398).

TENSOR FASCIÆ FEMORIS. This muscle is situated at the upper and outer part of the thigh. It *arises* from the external lip of the crest of the ilium, close to the anterior superior spine. It descends with a slight inclination backwards, and is *inserted*, at the junction of the upper with the middle third of the thigh, between two layers of the strong aponeurosis, generally described as part of the fascia lata * (p. 500). Its chief use is to fix the pelvis steadily on the thigh, and to rotate the thigh inwards; in this last action it co-operates with the anterior fibres of the gluteus medius, with which it is almost inseparably connected. Anyone may convince himself of this by placing his hand on the hip, and rotating

* The deeper of these two layers runs up to be strongly connected with the tendon of the rectus and the front of the capsule of the hip-joint.

the thigh inwards. Both these muscles are supplied by the same nerve—the superior gluteal.

To form an adequate idea of the strength, extent, and connections of the aponeurosis on the outer side of the thigh, it should be separated from the vastus externus muscle upon which it lies. There is no difficulty in doing so, for it is united to the muscle by an abundance of loose connective tissue.* With a little perseverance the aponeurosis can be traced to the linea aspera, the head of the tibia, and the fibula, completely protecting the outer side of the knee-joint.

Extensor Muscles or Quadriceps Muscle. The powerful muscles occupying the front of the thigh, and situated between the tensor fasciæ on the outer side and the adductors on the inner, are extensors of the leg. One of them—the *rectus*—arises from the pelvis; the other—the triceps—arises from the shaft of the thigh bone by three portions, called, respectively, the *cruræus*, the *vastus internus* and *externus*. All are supplied by the anterior crural nerve.

To see the origins of the rectus femoris, dissect between the origin of the sartorius and the tensor fasciæ; in doing so, avoid injuring the branches of the external circumflex artery.

Rectus Femoris. This muscle *arises* from the pelvis by two strong tendons, which soon unite at an acute angle: one—round—from the anterior inferior spine of the ilium, the other—flat—from the rough surface of the ilium, just above the acetabulum. The muscle descends along the front of the thigh, and is *inserted* into the common extensor tendon, which will be presently examined. The structure of this muscle is remarkable. A tendon runs down the centre, and the muscular fibres are inserted on either side of it, like the vane on the shaft of a feather. Its nerve comes from the anterior crural.

Triceps Extensor. This mass of muscle invests like a cloak the greater part of the front and sides of the shaft of the femur; therefore the whole of it cannot be

* When this tissue becomes the seat of suppuration, the pus is apt to extend all down the outside of the thigh, not being able to make its way to the surface by reason of the dense fascia.

seen without completely dissecting the thigh. It consists of an outer, middle, and inner portion, called, respectively, the vastus externus, the crureus, and the vastus internus. The *vastus externus* arises by a strong aponeurosis from the outer side of the base of the great trochanter, and from the outer lip of the linea aspera nearly down to the external condyle. The *crureus* and the *vastus internus arise* (conjointly) from the upper three-fourths of the front and inner surfaces of the shaft of the femur, and from the entire length of the inner lip of the linea aspera. The ultimate *insertion* of the several parts of the triceps is (through the patella) into the common extensor tendon of the knee.

A few of the deeper fibres of the crureus are inserted into the fold of the synovial membrane of the knee-joint which rises above the patella. These are described as a distinct muscle, under the name of the *sub-crureus*. Their use is to raise the synovial membrane, so that it may not be injured by the play of the patella. Since the triceps is connected to the lower part of the shaft of the femur only by loose connective tissue, there is nothing to prevent the distension of the synovial membrane, in cases of inflammation, to the extent of several inches above the patella.

COMMON EXTENSOR TENDON. The tendon of the rectus, gradually expanding, becomes connected on its under surface with the tendon of the crureus, and on either side with that of the vasti, and is firmly fixed into the upper part and sides of the patella. From this bone the common extensor tendon, the *ligamentum patellæ*, descends over the front of the knee-joint, and is *inserted* into the rough part of the tubercle of the tibia. Besides this, the lower fibres of the vasti terminate on a sheet-like tendon, which runs wide of the patella on either side, and is directly inserted into the sides of the head of the tibia and fibula, so that the knee is completely protected all round. The patella is a large sesamoid bone, interposed to facilitate the play of the tendon over the condyles of the femur: it not only materially protects the joint, but adds to the power of the extensor muscles, by increasing the angle at which the tendon is inserted into the tibia.

To facilitate the play of the extensor tendon there are two

bursæ. One is placed between the ligamentum patellæ and the smooth part of the tubercle of the tibia, the other between the crureus and the lower part of the femur. This last is of considerable size. In early life it is, as a rule, distinct from the synovial membrane of the knee-joint; but after a few years a wide communication frequently exists between them.

ACTION OF THE EXTENSOR MUSCLES. The extensor muscles of the thigh are among the most powerful in the body. Great power of extending the knee is one of the essential conditions of the erect attitude. Without it, how could we rise from the sitting position? When erect, how could we walk, run, or spring? The rectus, by taking origin from the pelvis, gains a double advantage; it acts upon two joints simultaneously, bending the thigh while it extends the knee, as when we advance the leg in walking: it also contributes to balance the pelvis on the head of the thigh bone, and thus prevents the body from falling backwards. We cannot have a better proof of the power of the extensor muscles than when the patella is broken by their sudden contraction; an injury which sometimes happens when a man, slipping backwards, makes a violent effort to recover his balance.

BURSA OVER THE PATELLA. The skin over the patella is exceedingly loose, and in the subcutaneous tissue is a bursa of considerable size. Since this bursa is apt to enlarge and inflame in females who are in the habit of kneeling at their work, it is generally called the housemaid's bursa. The bursa is not seated precisely over the patella, but extends some way down the ligamentum patellæ; indeed, in some cases it is entirely confined to this ligament. This corresponds with the position of the tumour which the bursa occasions when enlarged. Generally speaking, in subjects brought for dissection, the wall of the bursa is more or less thickened, and its interior intersected by numerous fibrous cords, remnants of the original cellular structure altered by long-continued friction. Again, the wall of the bursa does not always form a complete sac; sometimes there is a wide opening in it; this explains the rapidity with which inflammation, in some cases, extends from the bursa into the surrounding areolar tissue.

Below the bursa is a layer of fascia lata, and under this is a network of arteries. The immediate covering of the bone, or what may be called its periosteum, is a strong expansion derived from the extensor tendon. This is interesting for the following reason: in ordinary fractures of the patella from muscular action the tendinous expansion over it is torn also; the ends of the bone gape widely, and never unite except by ligament. But in fractures from direct mechanical violence, the tendinous expansion, being entire, maintains the fragments in apposition, so that there is commonly a bony union.

Course and Relations of the Femoral Artery.

The *femoral artery* is a continuation of the external iliac. Passing beneath the crural arch at a point midway between the spine of the ilium and the symphysis pubis, it descends along the front and inner side of the thigh. At the junction of the upper two-thirds with the lower third of the thigh, it passes through an opening in the tendon of the adductor magnus, and entering the ham, takes the name of popliteal. A line drawn from the point indicated of the crural arch to the adductor tubercle on the internal condyle corresponds with the course of the artery. Its distance from the surface increases as it descends. Immediately under, and for a short distance below the crural arch, it is supported by the inner border of the psoas; lower down it runs in front of the pectineus, but separated from it by the profunda vessels; still lower down it lies upon the adductor longus, and then upon the adductor magnus.

That part of the artery which extends from the crural arch to the giving off of the profunda, is called the common femoral artery; its continuation beyond the profunda is termed the superficial femoral; and it is the latter vessel which is ligatured for aneurysm of the popliteal artery.

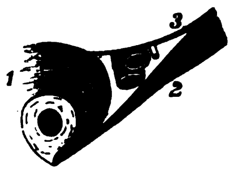
In the upper third of the thigh, the artery is situated in Scarpa's triangle, and is comparatively superficial, being covered only by the muscular fascia, and the sheath of the femoral vessels. About the middle third it is more deeply seated, and is covered by the sartorius; and lower down by a tendinous aponeurosis,

which stretches from the adductor longus and magnus over to the vastus internus. This, which forms part of Hunter's canal, will be examined presently.

At the crural arch the anterior crural nerve is placed on the outer side of the artery (separated from it by a few fibres of the psoas), and the femoral vein on the inner side: as the vein descends, it gradually passes behind the artery. Artery and vein lie close together, and are enclosed in a common sheath.

HUNTER'S CANAL. In the middle third of the thigh, the femoral artery is contained in a tendinous canal* beneath the sartorius, called *Hunter's canal.* This canal at its upper part is rather indistinct; but it gradually becomes stronger towards the opening in the tendon of the adductor magnus. Its boundaries are formed by the tendons of the muscles between which the artery runs. On the inner side are the tendons of the adductor longus and magnus; on the outer side is the tendon of the vastus internus; in front the canal is completed by an aponeurotic expansion thrown obliquely across from the adductors to the vastus internus, as shown in fig. 120. In a horizontal section the canal appears triangular. The adaptation of this shape to the exigencies of the case is manifest when we reflect that the muscles keep the sides of the triangle always tight, and thereby prevent any compression of the vessels.

FIG. 120.



SECTION THROUGH HUNTER'S CANAL.

1. Vastus internus.
2. Adductor longus.
3. Aponeurosis thrown across

Hunter's canal contains not only the femoral artery and vein, but the internal saphenous nerve. The vein lies behind and to the outer side; the nerve crosses from the outer to the inner side of the artery.

A ligature can be placed around the artery, in the upper third of the thigh, with comparative facility; not so easily in the middle third. The artery is tied for an aneurysm of the popliteal,

* Called Hunter's canal, because it was in this part of its course that John Hunter first tied the femoral artery for aneurysm of the popliteal, in St. George's Hospital, A.D. 1785. The particulars of this interesting case are published in the 'Trans. for the Improvement of Med. and Chir. Knowledge.'

just where the sartorius begins to overlap it, for three reasons:—1, it is more accessible; 2, the coats of the artery at this distance are less likely to be diseased; 3, the origin of the profunda is sufficiently far off to admit of the formation of a clot. An incision, beginning about three inches below the crural arch, should be made about three inches long over the line of the artery. The muscular fascia should be divided on a director to the same extent. Then, by gently drawing aside the inner border of the sartorius, the artery is seen enclosed in its sheath with the vein. An opening should be made into the sheath, which must be carefully separated from the artery to an extent sufficient to allow the passage of the aneurysmal needle. The needle should be turned round the artery from within outwards, great care being taken not to injure the vein. The nerves to be avoided are—the long saphenous, which runs along the outer side of the artery, and the internal cutaneous which crosses obliquely over it.

Having already traced the superficial branches of the femoral artery in the groin, namely, the superficial epigastric, the external pudic, and the superficial circumflexa ilii (p. 497), we pass on now to the profunda.

PROFUNDA ARTERY AND BRANCHES.

The *profunda*, the chief branch of the femoral, is the proper nutrient artery of the muscles of the thigh, and is by many considered as a division, rather than a branch, of the common femoral artery. It is given off from the outer and back part of the femoral, from one and a half to three inches below the crural arch, and runs down behind the femoral till it reaches the tendon of the adductor longus; here the profunda passes behind the adductor, and is finally lost in the hamstring muscles.* In most subjects, the profunda, for a short distance after its origin, lies rather on the outer side of the femoral and on a deeper plane, over the iliacus internus: in this situation it might be mistaken

* The point at which the profunda is given off below the crural arch varies very much even in the two limbs of the same body. We have measured it in 19 bodies, or 38 femoral arteries. It varied from ½ to 3 inches. In 22 cases the profunda came off between 1½ and 2 inches; in 9 this distance was exceeded; in 7 this distance was less.

for the femoral itself—indeed, such an error has occurred in practice. It soon, however, gets behind the femoral, and lies upon the pectineus, the adductor brevis and magnus; it is separated from the femoral artery at first, by their corresponding veins; lower down, by the adductor longus.

The branches of the profunda generally arise in the following order:—1, the internal circumflex; 2, the external circumflex; 3, the perforating.

The *internal circumflex* is given off from the inner and back part of the profunda, and then sinks deeply into the thigh between the psoas and pectineus. At the lower border of the obturator externus it divides into two branches: one—the *ascending*—supplies the muscles in its neighbourhood, namely, the pectineus, psoas, adductors, gracilis, and obturator externus, anastomosing with the obturator artery; the other—the *transverse*—will be seen in the dissection of the back of the thigh, between the adductor magnus and the quadratus femoris. This latter sometimes gives off a small branch to the hip-joint, which runs through the notch in the acetabulum to the ligamentum teres; it afterwards inosculates with the ischiatic and superior perforating arteries.

The *external circumflex* artery comes off from the outer side of the profunda, runs transversely outwards beneath the sartorius and rectus between the branches of the anterior crural nerve, and then subdivides into three sets of branches, ascending, transverse, and descending. The *ascending* run up to the outer side of the ilium, beneath the tensor fasciæ and gluteus medius, supply these muscles, and inosculate with the terminal branches of the gluteal artery. The *transverse* pass directly outwards over the crureus, then enter the vastus externus, and get between the muscle and the femur. They inosculate with the ischiatic, the internal circumflex, the gluteal, and the perforating arteries. The *descending*, one or more in number, of considerable size, run down between the rectus and crureus, and supply both these muscles: one branch, larger than the rest, runs down in the substance of the vastus externus, along with the nerve to that muscle, and inosculates with the articular branches of the popliteal.

The *perforating* branches of the profunda are so named because they pass through the adductors to supply the hamstring muscles. There are generally four. The *first* passes through the adductor brevis and magnus, and communicates with the internal circumflex and ischiatic arteries.

The *second*, the largest, passes through the tendons of the adductor brevis and magnus, and usually furnishes the nutrient artery of the femur. The *third*, passes through the tendon of the adductor magnus. The *fourth*, or terminal branch, passes through the tendon of the adductor magnus, and supplies the hamstring muscles, and inosculates with the perforating and articular arteries. They not only supply the hamstring muscles—namely,

FIG. 121.

1. Crural arch.
2. Internal iliac.
3. Superficial femoral.
4. Profunda.
5. Internal circumflex.
6. External circumflex.

7. First perforating.
8. Second ditto.
9. Third ditto.
10. Gluteal.
11. Obturator.
12. Ischiatic.
13. Anastomotica magna.

PLAN OF THE INOSCULATIONS OF THE CIRCUMFLEX ARTERIES.

the biceps, semitendinosus, and semimembranosus—but, the vastus externus and even the gluteus maximus. The perforating arteries inosculate with one another, with the internal and external circumflex, and with the ischiatic arteries.

ARTERIAL INOSCULATIONS.

If the common femoral were tied *above* the origin of the profunda, how would the circulation

be carried on? The ascending branch of the external circumflex communicates with the gluteal and the circumflex iliac; the internal circumflex communicates with the obturator and ischiatic (see fig. 121). Again—how is the circulation maintained when the superficial femoral is tied *below* the profunda? The descending branch of the external circumflex and the perforating branches of the profunda communicate with the articular branches of the popliteal and the tibial recurrent.*

The *anastomotica magna* arises from the femoral artery just before it leaves its tendinous canal. It emerges through the canal, and runs in front of the tendon of the adductor magnus, in company with the long saphenous nerve to the inner side of the knee. Here it divides into two branches: one, the *superficial*, accompanies the saphenous nerve, and is subsequently distributed to the skin; the other, the *external*, ramifies over the capsule and communicates with the other articular arteries.†

ANTERIOR CRURAL NERVE. The anterior crural nerve is the largest branch of the lumbar plexus (p. 409). It comes from the third and fourth lumbar nerves, sometimes also from the second. It passes beneath the crural arch, lying in the groove between the iliacus internus and psoas, about a quarter of an inch to the outer side of the artery, and soon divides into branches, some of which are cutaneous, but the greater number supply the extensor muscles of the thigh. The cutaneous branches, already described (p. 499), and the long saphenous nerve, are given off from the *superficial* part of the trunk; the muscular from the *deep* part.

The *long saphenous nerve* descends close to the outer side of the femoral artery, and enters the tendinous canal with it in the middle third of the thigh. In the canal it crosses over the artery to its inner side. The nerve leaves the artery just before it becomes popliteal, and then

* Read the account of the dissection of an aneurysmal limb by Sir A. Cooper, 'Med. Chir. Trans.' vol. ii.

† In its course down the thigh the femoral artery gives off several small branches to the sartorius, and one of considerable size for the supply of the vastus internus. We may trace this branch through the substance of the vastus down to the patella, where it joins the network of vessels on the surface of that bone.

runs in company with the anastomotica magna to the inner side of the knee, where it becomes superficial, between the gracilis and the sartorius. In the middle third of the thigh it gives off a small branch which communicates beneath the fascia lata with the internal cutaneous and obturator nerves; and lower down another branch is distributed to the skin over the patella. Its further relations will be seen in the dissection of the leg and foot.

The *muscular branches* are to be traced to the sartorius, rectus, crureus, and subcrureus; the branch to the vastus externus accompanies the descending branch of the external circumflex artery, and sends a filament to the knee-joint; that to the vastus in ternus runs parallel with, but external to, the long saphenous nerve, and supplies filaments to the knee-joint. One branch passes under the femoral artery and vein to enter the anterior surface of the pectineus.

The *obturator nerve*, also a branch of the lumbar plexus (p. 409), supplies the adductor muscles. It enters the thigh through the upper part of the obturator foramen above the corresponding artery, and immediately divides into two branches, of which one passes in front of, the other behind, the adductor brevis. The *anterior* branch subdivides for the supply of the gracilis, the adductor longus, and sometimes the adductor brevis and pectineus; it, moreover, sends a filament to the hip-joint, another to the femoral artery; and a third forms a plexiform communication at the lower border of the adductor longus with the internal cutaneous and long saphenous nerves. The *posterior* branch supplies the obturator externus, the adductor brevis and magnus. In some bodies you can trace a filament of this nerve through the notch of the acetabulum into the hip-joint, and another, which runs near the popliteal artery into the back part of the knee-joint. We have frequently seen cutaneous branches from the obturator on the inner side of the thigh. This is interesting practically, since it helps to explain the pain often felt on the inner side of the knee in disease of the hip-joint.

The *obturator artery*, after passing through the foramen, divides into two branches, an *internal* and an *external*, which form a circle round the obturator membrane. These supply the external obturator and adductors of the thigh, and inosculate

with the internal circumflex artery (p. 522). The latter branch sometimes gives off the small artery to the ligamentum teres of the hip-joint.

DISSECTION OF THE FRONT OF THE LEG.

The foot should be turned inwards, and fixed in this position. An incision must be made from the knee, down the front of the leg, over the ankle, along the top of the foot to the great toe; a second, at right angles to the first, on either side of the ankle; a third, across the bases of the toes. Reflect the skin from the front and sides of the leg and foot.

CUTANEOUS VEINS AND NERVES. Having traced the internal saphena vein (p. 499) to the inner side of the knee, follow it down the inner side of the leg, in front of the inner ankle* to the dorsum of the foot. On the dorsum of the foot notice that the principal veins form an arch, with the convexity forwards, as on the back of the hand. This arch receives the veins from the toes. From the inner side of the arch the internal saphena originates: from the outer side, the external saphena. The latter vein runs behind the external ankle, up the back of the calf of the leg to join the popliteal vein.

LONG SAPHENOUS NERVE. The skin on the inner side of the leg is supplied by the long or internal saphenous nerve (p. 523). It becomes subcutaneous on the inner side of the knee, between the gracilis and sartorius. Here it meets the saphena vein, and accompanies it down the leg, distributing its branches on either side, till it is finally lost on the inner side of the foot and the great toe. The largest branch curves round the inner side of the knee, just below the patella, to supply the skin in this situation. It pierces the sartorius close to the knee, and forms with branches from the internal, middle, and external cutaneous nerves, the *plexus patellæ*.

* The French commonly bleed from the internal saphena vein as it crosses over the inner ankle, this being a convenient and safe place for venesection.

The *internal cutaneous nerve* supplies the skin of the upper and inner aspect of the leg, and joins the internal saphenous nerve.

The skin on the front and outer parts of the upper half of the leg is supplied by cutaneous branches from the external popliteal or peroneal nerve; the skin of the lower half, by its external cutaneous branch as follows:—

EXTERNAL CUTANEOUS BRANCH OF THE PERONEAL NERVE.

This branch of the peroneal nerve comes through the fascia about the lower third of the outer side of the leg; and descending over the front of the ankle, divides into two. Trace them, and you will find that the *inner* and smaller supplies the inner side of the great toe, and the contiguous sides of the second and third toes; towards its termination it communicates with the long saphenous and anterior tibial nerves. The *outer* distributes branches to the outer side of the third toe, both sides of the fourth, and the inner side of the fifth toe, and joins the short (or external) saphenous nerve.

The outside of the little toe is supplied by the short saphenous nerve, which runs behind the outer ankle with the corresponding vein.

The contiguous sides of the great and second toes are supplied by the termination of the anterior tibial nerve.*

MUSCULAR FASCIA AND ANNULAR LIGAMENTS.

This is remarkably thick and strong. Besides its general purpose of forming sheaths for the muscles, and straps for the tendons, it gives origin, as in the forearm, to muscular fibres; so that it cannot be removed near the knee, without leaving the muscles ragged. The fascia is attached to the head of the tibia and the fibula: it is identified on the inner side with the expanded tendons of the sartorius, gracilis, and semi-tendinosus; on the outer side with that of the biceps: consequently, when these muscles act, it is rendered tense. Following it down the leg, you find that it is attached to the edge of the tibia, and that it

* Such is the most common distribution of the nerves to the upper surface of the toes. But deviations from this arrangement are frequent.

becomes stronger as it approaches the ankle, to form the ligaments which confine the tendons in this situation. Of these ligaments, called *annular*, there are three, as follows :—

a. The *anterior annular* extends obliquely across the front of the ankle-joint, and confines the extensor tendons of the ankle and toes. It consists of two converging straps, which join, and are continued on as a common band, like the letter ⋈ placed transversely. The common band is attached to the external malleolus, cuboid and os calcis: it is continued horizontally inwards, and in front of the ankle splits into two fasciculi ; the upper is attached to the tibia; the lower into the scaphoid and internal cuneiform. It is the strain of this ligament which occasions the pain in sprains of the ankle. You will see presently that it makes a pulley for the extensor longus digitorum.

b. The *external annular* extends from the outer malleolus to the os calcis, and confines the tendons of the peronei muscles, which draw the foot outwards.

c. The *internal annular* is ill defined, and extends from the inner malleolus to the os calcis, and binds down the flexor tendons of the foot and toes.

Remove the fascia, leaving enough of the annular ligaments to retain the tendons in their places.

MUSCLES ON THE FRONT OF THE LEG. The muscles on the front of the leg are :—1, the tibialis anticus; 2, the extensor longus digitorum and peroneus tertius; 3, the extensor proprius pollicis.

TIBIALIS ANTICUS. The tibialis anticus *arises* from the external tuberosity and the upper two-thirds of the outer side of the tibia, from the interosseous membrane, from the fascia which covers it, and from that which separates it from the next muscle. About the lower third of the leg the fibres terminate on a strong flat tendon, which descends obliquely over the front of the ankle to the inner side of the foot ; here it becomes a little broader, and is *inserted* into the internal cuneiform bone and the tarsal end of the metatarsal bone of the great toe. The synovial membrane, which lines the sheath of the tendon beneath

the anterior annular ligament, accompanies it to within an inch of its insertion; consequently it is opened when the tendon is divided for club-foot. The action of this muscle is to draw the foot upwards and inwards.* When the foot is the fixed point, it assists in balancing the body at the ankle. Its nerve comes from the anterior tibial.

EXTENSOR LONGUS DIGITORUM. This muscle lies along the fibular side of the preceding. It *arises* from the external tuberosity of the tibia, from the upper three-fourths of the inner surface of the fibula, from the interosseous membrane, from the fascia and the intermuscular septa. Its fibres terminate in a penniform manner upon a long tendon, situated on the inner side of the muscle: this tendon descends in front of the ankle and divides into four slips, which pass to the four outer toes. They diverge from each other, and are *inserted* into the toes thus:—on the first phalanx, each tendon (except that of the little toe) is joined on its outer side by the corresponding tendon of the extensor brevis. The united tendons then expand, and are inserted as on the fingers; that is, the middle part is inserted into the base of the second phalanx; the sides run on to the base of the third (p. 329). Its nerve comes from the anterior tibial.

Immediately below the ankle the anterior annular ligament forms a pulley through which the tendon of this muscle plays. It is like a sling, of which the two ends are attached to the os calcis, while the loop serves to confine the tendon. The play of the tendon is facilitated by a synovial membrane, which is prolonged for a short distance along each of its four divisions. Besides its chief action, this muscle extends the ankle-joint.†

PERONEUS TERTIUS. This appears to be a portion of the preceding. Its fibres *arise* from the lower part of the inner surface of the shaft of the fibula, the interosseous membrane, and the intermuscular septum, and terminate on their tendon-like barbs

* It is generally necessary to divide this tendon in distortion of the foot inwards, called talipes varus.

† There is often a large bursa between the tendon of the extensor longus digitorum and the outer end of the astragalus. This bursa sometimes communicates with the joint of the head of the astragalus.

on a quill. The tendon passes through the same pulley with the long extensor of the toes, and, expanding considerably, is *inserted* into the tarsal end of the metatarsal bone of the little toe. It is supplied by a branch of the anterior tibial nerve.

The peroneus tertius and the tibialis anticus are important muscles in progression. They raise the toes and foot from the ground. Those who have lost the use of these muscles are obliged to drag the foot along the ground, or to swing the entire limb outwards, in walking.

EXTENSOR PROPRIUS POLLICIS. This muscle lies partly concealed between the tibialis anticus and the extensor longus digitorum. It *arises* from rather more than the middle third of the inner surface of the fibula, and from the interosseous membrane. The fibres terminate in a penniform manner on the tendon, which runs over the ankle, between the tendons of the tibialis anticus and the extensor communis digitorum, along the top of the foot, to the great toe, where it is *inserted* into the base of the last phalanx. It has a special pulley beneath the annular ligament, lined by a synovial membrane, which accompanies it as far as the metatarsal bone of the great toe. It is supplied by the anterior tibial, a branch of the peroneal nerve.

Now examine the course, relations, and branches of the anterior tibial artery. Since it lies deeply between the muscles, it is necessary to separate them from each other: this is easily done by proceeding from the ankle towards the knee.

COURSE AND RELATIONS OF THE ANTERIOR TIBIAL ARTERY. The *anterior tibial artery* is one of the two branches into which the popliteal divides at the lower border of the popliteus. It comes at first horizontally forward about 1¼ inches below the head of the fibula, above the interosseous membrane, and then descends, lying in rather more than the first half of its course upon the interosseous membrane, afterwards along the front of the tibia. It runs beneath the annular ligament over the front of the ankle, where it takes the name of the dorsal artery of the foot. Thus, a line drawn from the head of the fibula to the interval between the first and second metatarsal bones would nearly indicate its

course. In the upper third of the leg it lies deeply between the tibialis anticus and the extensor longus digitorum ; in the lower two-thirds, between the tibialis anticus and the extensor proprius pollicis. In *front of the ankle* the artery is crossed by the extensor proprius pollicis, and lies between the tendon of this muscle and the inner tendon of the extensor longus digitorum.

The artery is accompanied by the anterior tibial nerve (a branch of the peroneal), which runs for some distance upon its fibular side, then in front of it, and lower down is again situated on its outer side. It is accompanied by two veins, one on each side, which communicate at intervals by cross branches.

The branches of the anterior tibial are as follows :—

a. The *recurrent* branch ascends close by the outer side of the head of the tibia, through the tibialis anticus, to the front of the knee-joint, where it inosculates with the other articular arteries derived from the popliteal.

b. Irregular *muscular* branches, in its course down the leg.

c. The *malleolar* branches, *external* and *internal*, ramify over the ankle : the *external*, descending beneath the tendon of the extensor longus digitorum, ramifies on the external malleolus, inosculating with the anterior peroneal and the tarsal arteries ; the *internal* passes beneath the tibialis anticus, and anastomoses with the posterior tibial. They supply the joint, the articular ends of the bones, and the sheaths of the tendons around them.

EXTENSOR BREVIS DIGITORUM. This muscle is situated on the dorsum of the foot, beneath the long extensor tendons of the toes. It *arises* from the outer part of the os calcis, from the ligament uniting this bone to the astragalus, and from the anterior annular ligament. The fibres run obliquely over the foot, and terminate in four tendons, which pass forwards to the four inner toes. The inner one is *inserted* by an expanded tendon into the base of the first phalanx of the great toe ; the others *join* the fibular side of the long extensor tendons to be inserted with them into the second and ungual phalanges. The tendon to the great toe crosses over the dorsal artery of the foot. It is supplied by a branch of the anterior tibial nerve.

Dorsal Artery of the Foot. This artery, the continuation of the anterior tibial, runs over the instep to the interval between the first and second metatarsal bones, where it sinks into the sole and joins the deep plantar arch. On the dorsum of the foot it runs along the outer side of the extensor proprius pollicis, and before it dips down into the sole, is crossed by the short extensor tendon of the great toe. The dorsal artery gives off the following branches:—

a. The *tarsal* branch arises near the scaphoid bone, passes beneath the extensor brevis digitorum towards the outside of the foot, supplies the bones and joints of the tarsus, and inosculates with the external malleolar, the peroneal, the metatarsal, and the external plantar arteries.

b. The *metatarsal* branch generally runs towards the outside of the foot, beneath the short extensor tendons, near the bases of the metatarsal bones, and gives off the three outer *interosseous arteries.* These pass forwards over the corresponding interosseous muscles, supply them, and then subdivide to supply the contiguous sides of the upper surfaces of the toes. They communicate by perforating branches with the plantar arteries at each end of the interosseous spaces.

c. The *dorsalis hallucis* is, strictly speaking, the artery of the first interosseous space. It comes from the dorsal artery of the foot just before this sinks into the sole, and runs forwards to supply *digital branches* to the sides of the great toe, and the inner side of the second toe.

Peronei Muscles. These muscles are situated on the outer side of the fibula, and are named, respectively, peroneus longus and brevis.

Peroneus Longus. This *arises* from the outer surface of the fibula along its upper two-thirds, from the fascia and the intermuscular septa. The fibres terminate in a penniform manner upon a tendon, which runs through a groove behind the external malleolus, then along the outer side of the os calcis, and, lastly, through a groove on the under surface of the os cuboides deep into the sole. It crosses the sole obliquely forwards and inwards, and is *inserted* into the tarsal end of the metatarsal bone of the great toe. In its course through these several bony grooves the tendon is confined by a fibrous sheath, lined by a synovial

membrane. In removing the metatarsal bone of the great toe, if possible, leave the insertion of this tendon. Its nerve comes from the peroneal.

PERONEUS BREVIS. This muscle lies beneath the preceding. It *arises* from about the middle third of the outer surface of the fibula, internal to the preceding muscle, and from the intermuscular septa. It terminates on a tendon which runs behind the external malleolus, through the same sheath with the peroneus longus, then proceeds along the outside of the foot and is *inserted* into the tarsal end of the metatarsal bone of the little toe.* Its nerve is from the peroneal.

The *action* of the peronei is to raise the outer side of the foot.† This movement regulates the bearing of the foot in progression, so as to throw the principal part of the weight on the ball of the great toe. Its action is well exemplified in skating. Again, supposing the fixed point to be at the foot, they tend to prevent the body from falling on the opposite side, as when we balance ourselves on one leg.

PERONEAL OR MUSCULO-CUTANEOUS NERVE. Near the inner side of the tendon of the biceps flexor of the leg, is a large nerve, the external popliteal or peroneal, a branch of the great ischiatic. By reflecting the upper part of the peroneus longus, you will find that this nerve runs round the outer side of the fibula immediately below its head. Here it divides into several branches, as follows:—1. *Articular* branches to the knee-joint, which pass in with the external articular arteries, and the tibial recurrent artery; 2. The *anterior tibial*, which accompanies the corresponding artery and supplies the muscles between which it runs, namely the tibialis anticus, extensor longus digitorum, extensor proprius pollicis—and peroneus tertius: also the extensor brevis digitorum; 3. The *external-cutaneous* (p. 526), which comes through the fascia between the

* On the outside of the os calcis there is a ridge which separates the tendons of the peronei. Each has a distinct sheath. The short tendon runs above, the long one below the ridge.

† In distortion of the foot outwards, called talipes valgus, it is generally necessary to divide the tendons of the peronei.

peroneus longus and the extensor longus digitorum; 4. *Branches*, which supply the peronei (longus and brevis) muscles.

If, then, the peroneal nerve were divided in the popliteal space, the result would be paralysis of the tibialis anticus, the extensors of the toes—long and short—and all the peronei.

DISSECTION OF THE GLUTEAL REGION.

The body having been placed on its face, the pelvis is to be raised to such a height by blocks placed beneath it, that the lower extremities hang down over the end of the table. Then rotate the thighs inwards as much as possible, and cross them.

The incision through the skin should commence at the coccyx, and be continued in a semicircular direction along the crest of the ilium. Another incision should be made from the coccyx downwards and outwards for about six inches below the great trochanter. In reflecting the skin, notice the thick cushion which the subcutaneous adipose tissue forms over the tuberosity of the ischium. A large bursa is often formed between the cushion and the bone.

CUTANEOUS NERVES. These are derived from several sources. The posterior divisions of the *first* and *second lumbar* nerves descend over the crest of the ilium, near the origin of the erector spinæ, to supply the skin over the gluteus maximus as far as the great trochanter. Internal to these, are the posterior branches of the three upper *sacral nerves*, which are distributed to the integument over the sacrum and coccyx. Over the middle of the crest, come the lateral branches of the *twelfth dorsal*, and posterior to it, the *iliac branch* of the ilio-hypogastric. Other cutaneous nerves ascend from below; they are branches of the *lesser ischiatic*, and proceed from beneath the lower border of the gluteus maximus. Lastly, some branches from the *external cutaneous* nerve of the thigh are seen on the outer side of this region.

GLUTEAL MUSCLES. Three powerful muscles are situated in the region of the buttock, one above the other, named, according to their size, the gluteus maximus, medius, and minimus.

The fascia covering the gluteus maximus is comparatively thin, posteriorly, where it is attached to the sacrum, coccyx, and ilium; but anteriorly it is very dense and glistening, and gives origin to the fibres of the gluteus medius, and lower down becomes continuous with the fascia lata.

GLUTEUS MAXIMUS. This is the largest muscle of the body, and is covered by a fascia, which sends prolongations inwards between the muscular bundles. Its great size is characteristic of man, in reference to his erect position. Its texture is thick and coarse. It arises from the posterior fifth of the crest of the ilium, and from the rough surface below it, from the lower part of the sacrum, the coccyx, and the great sacro-ischiatic ligament. The fibres descend obliquely forwards, and are *inserted* thus:—the anterior two-thirds terminate on a strong broad aponeurosis which plays over the great trochanter, and joins the fascia lata on the outside of the thigh (p. 500); the remaining third is inserted into the femur, along the ridge (gluteal) leading from the linea aspera to the base of the great trochanter.

This muscle *extends* the thigh bone upon the pelvis, and is therefore one of those most concerned in raising the body from the sitting to the erect position, and in maintaining it erect. It propels the body—in walking, running or leaping, and rotates the thigh outwards. It is supplied with blood by the gluteal and ischiatic arteries; with nerves from the lesser ischiatic, and the sacral plexus.

WHAT IS SEEN BENEATH THE GLUTEUS MAXIMUS. The gluteus maximus should be reflected from its origin. The best way is to begin at the front border, which overlaps the gluteus medius. The dissection is difficult, and he who undertakes it for the first time, is almost sure to injure the subjacent parts. The numerous vessels which enter its under surface must be divided before the muscle can be reflected. This having been accomplished, the following objects will be exposed:—

The muscle covering the ilium is the gluteus medius. At the posterior border of this are the several objects which emerge from the pelvis through the great ischiatic notch—namely, the pyri-

formis muscle; above which is the trunk of the gluteal vessels and nerve, and, below which, are the greater and lesser ischiatic nerves, the arteria comes nervi ischiatici, the long pudendal nerve, the ischiatic vessels, the pudic vessels and nerve, and the nerve to the obturator internus. Coming through the lesser ischiatic notch, is the tendon of the obturator internus, and attached to it are the gemelli muscles, one above, the other below it. Extending from the tuber ischii transversely outward to the great trochanter is the quadratus femoris, and, below this, is seen the upper part of the adductor magnus. The origins of the semi-membranosus, biceps, semitendinosus, and of the adductor magnus, from the tuber ischii, are also seen; as well as the great sacro-ischiatic ligament, which passes upwards to the sacrum, and is pierced by the coccygeal branch of the ischiatic artery. The great trochanter is exposed, together with a small portion of the vastus externus; and where the tendon of the gluteus maximus plays over the trochanter major, there is a large bursa, simple or multilocular. Lastly, the side of the sacrum, the coccyx, part of the crest of the ilium, the tuberosity of the ischium, and the coccygeus muscle are brought into view.

GLUTEUS MEDIUS. This muscle *arises* from the surface of the ilium, between the crest and the upper curved line; also from the strong fascia which covers it towards the front. The fibres converge to a tendon, which is *inserted* into the upper and outer surface of the great trochanter: some of the anterior fibres—in immediate connection with the tensor fasciæ—terminate on the aponeurosis of the thigh. Between its insertion and the bone is a bursa.

Reflect the gluteus medius to see the third gluteal muscle. The line of separation between them is marked by a large branch of the gluteal artery.

GLUTEUS MINIMUS. This muscle *arises* from the surface of the ilium below the upper curved line. Its fibres pass over the capsule of the hip-joint, and converge to a tendon which is *inserted* into a depression on the front part of the great trochanter, a bursa being interposed. This muscle and the pre-

ceding are supplied by the superior gluteal nerve, a branch of the lumbo-sacral. The chief action of this and the preceding muscle is to assist in balancing the pelvis steadily on the thigh, as when we are standing on one leg; with the fixed point at the ilium, they are abductors of the thigh. The anterior fibres of the gluteus medius co-operate with the tensor fasciæ in rotating the thigh inwards.

GLUTEAL VESSELS AND NERVES. The gluteal artery is the largest branch of the internal iliac (p. 441). Emerging from the pelvis through the great ischiatic foramen between the pyriformis and the gluteus medius, it divides into large branches for the supply of the gluteal muscles. Of these, the more *superficial* proceed forwards between the gluteus maximus and medius, both of which they supply, and eventually anastomose with the posterior sacral and ischiatic arteries; others, *deeper*, run in curves between the gluteus medius and minimus, towards the anterior part of the ilium. Many of them inosculate with branches of the external circumflex, the deep circumflexa ilii, and the ischiatic arteries.

The nerve which accompanies the gluteal artery is a branch of the lumbo-sacral nerve (p. 445). It subdivides to supply the gluteus medius and minimus, and the tensor fasciæ; in some subjects it sends a branch to the gluteus maximus; but this muscle is chiefly supplied by the lesser ischiatic nerve.

A surgeon ought to be able to cut down and tie the gluteal artery as it emerges from the pelvis. The following is the best rule for finding it:—*

Draw a line from the posterior superior spine of the ilium to the trochanter major, rotated inwards. The junction of the upper with the middle third of this line lies over the artery as it emerges from the upper border of the great ischiatic notch.

Now examine the series of muscles which rotate the thigh outwards—namely, the pyriformis, the obturator internus, the gemelli, the quadratus femoris, and the obturator externus.

* The operation of tying the gluteal artery was first performed by John Bell. See his 'Principles of Surgery,' vol. i. p. 421.

PYRIFORMIS. This muscle lies immediately below and parallel to the lower fibres of the gluteus medius. It *arises* by three fleshy fasciculi from the second, third, and fourth segments of the front surface of the sacrum between the foramina for the sacral nerves, and from the margin of the great sacro-ischiatic notch. The fibres converge to a tendon which is *inserted* into the upper border of the trochanter major. Its nerve comes from the sacral plexus.

OBTURATOR INTERNUS. This muscle, of which little more than the tendon can be seen at present, *arises* within the pelvis, from the ischium between the great ischiatic notch and the obturator foramen, and superiorly as high as the brim of the pelvis, from the obturator membrane, and slightly also from the obturator fascia. The fibres terminate on four tendons which converge towards the lesser ischiatic notch, pass round it as over a pulley, and then uniting into one, are inserted into the top of the great trochanter, close to the digital fossa. Divide the tendon about three inches from its insertion, to see the four tendons which play over the smooth cartilaginous surface. There is a large synovial bursa to diminish friction. The nerve of this muscle comes from the sacral plexus; sometimes from the pudic nerve.

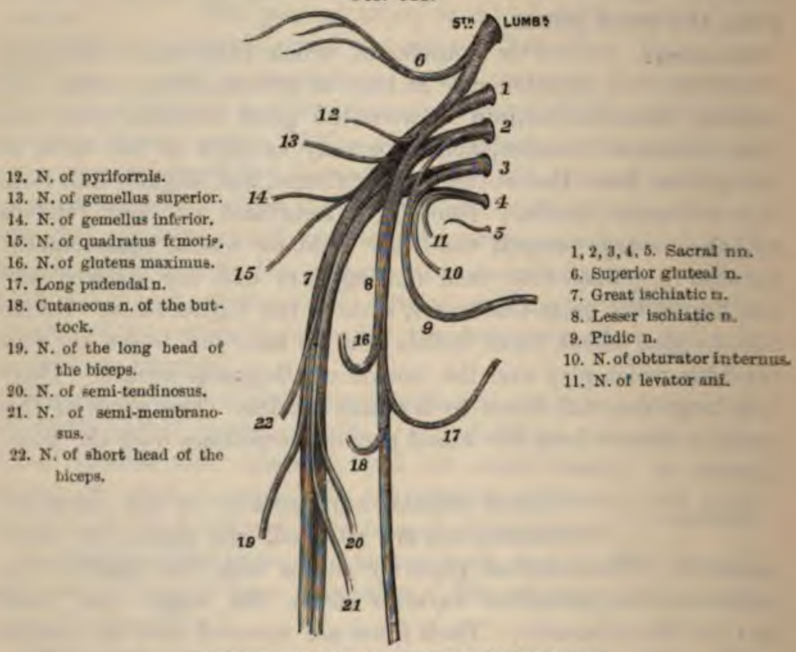
GEMELLI. These muscles are accessory to the obturator internus, and are situated, one above, the other below it. The *gemellus superior arises* from the spine of the ischium; the *gemellus inferior* from the upper and back part of the tuberosity. Their fibres are *inserted* into the tendon of the obturator internus. Both muscles derive their nerves from the sacral plexus.

QUADRATUS FEMORIS. This muscle *arises* from the ridge on the outer part of the tuber ischii. Its fibres run horizontally outwards, and are *inserted* into the back of the great trochanter, into the greater part of the linea quadrati. The lower border of the quadratus femoris runs parallel with the upper edge of the adductor magnus; in fact, it lies on the same plane. Between these muscles is generally seen a terminal branch of the internal

circumflex artery. Its nerve comes from the sacral plexus, and enters its deep surface.

OBTURATOR EXTERNUS. To see this muscle reflect the quadratus femoris. It *arises* from the outer surface of the os pubis, from the front surface of the ramus of the pubes and ischium, and from the obturator membrane. The fibres converge to a tendon

FIG. 122.



PLAN OF THE SACRAL PLEXUS AND BRANCHES.

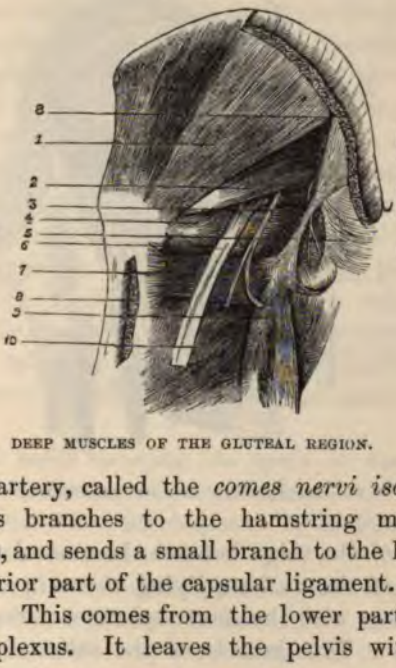
which runs horizontally outwards over a groove in the ischium, and is *inserted* into the deepest part of the digital fossa below the gemellus inferior. Its nerve is a branch of the posterior division of the obturator (p. 524).

GREAT ISCHIATIC NERVE. This large nerve is formed by the union of the last lumbar and four upper sacral nerves (fig. 122), and supplies all the flexor muscles of the lower extremity, and the extensors of the foot.

Emerging from the pelvis through the great sacro-ischiatic foramen below the pyriformis, it descends over the external rotator muscles of the thigh, along the interval between the tuber ischii and the great trochanter, but rather nearer to the former ; so that, in the sitting position, the nerve is protected from pressure by this bony prominence. The nerve does not descend quite perpendicularly, but rather obliquely forwards upon the adductor magnus, parallel with the great sacro-ischiatic ligament, and below the middle of the thigh divides into the internal popliteal and the peroneal (or external popliteal). It is accompanied by a branch

Fig. 123.

1. Gluteus medius.
2. Pyriformis.
3. Lesser sciatic nerve.
4. Obturator internus, with the two gemelli.
5. Coccygeus.



6. Great sciatic nerve.
7. Quadratus femoris.
8. Gluteus maximus.
9. The semitendinosus and biceps.
10. Adductor magnus.

DEEP MUSCLES OF THE GLUTEAL REGION.

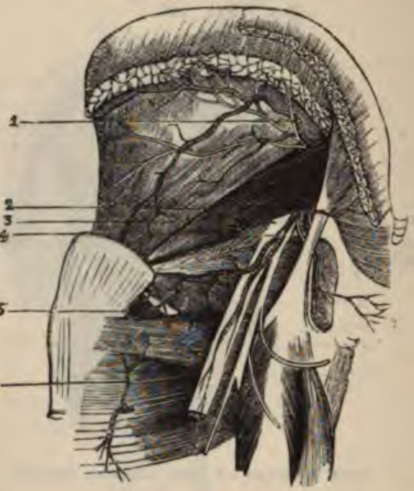
of the ischiatic artery, called the *comes nervi ischiatici.** The nerve distributes branches to the hamstring muscles and the adductor magnus, and sends a small branch to the hip-joint which pierces the posterior part of the capsular ligament.

Lesser Ischiatic Nerve. This comes from the lower part of the sacral plexus. It leaves the pelvis with the greater

* The arteria comes nervi ischiatici runs generally by the side of the nerve, but sometimes in the centre of it. This artery becomes one of the chief channels by which the blood reaches the lower limb after ligature of the femoral. See in the Museum of the Royal College of Surgeons a preparation in which the femoral was tied by John Hunter fifty years before the man's death.

ischiatic nerve, but on the inner side of it, and in company with the ischiatic artery. The muscular branches which it gives off are one or more—*inferior gluteal*—which enter the under surface of the gluteus maximus. All its other branches are cutaneous. One *external* turns round the lower border of the gluteus maximus, and supplies the skin of the buttock. Another, the inferior or *long pudendal* (p. 419), turns inwards towards the perineum, to supply the skin of that region and the scrotum. The continued trunk runs

FIG. 124.



1. Gluteal artery and nerve.
2. Pudic artery and nerve, and nerve to obturator internus.
3. Great sacro-ischiatic nerve.
4. Ischiatic artery.
5. Internal circumflex artery.
6. The first perforating artery.

THE ARTERIES OF THE GLUTEAL REGION.

down the back of the thigh beneath the muscular fascia, as low as the upper part of the calf, supplying the skin all the way down, and communicates with the short saphenous nerve.

ISCHIATIC ARTERY. This branch of the internal iliac leaves the pelvis between the pyriformis and the gemellus superior; it then descends between the tuber ischii and the great trochanter, along the inner side of the great ischiatic nerve. It gives off:—

1, two or more considerable branches to the gluteus maximus; 2, a *coccygeal* branch, which runs through the great sacro-ischiatic ligament, then ramifies in the gluteus maximus, and on the back of the coccyx; 3, the *comes nervi ischiatici*; 4, branches to the several external rotator muscles; lastly, branches which supply the upper part of the hamstring muscles; and others which inosculate with the internal circumflex and obturator arteries (p. 522).

PUDIC ARTERY AND NERVE. The course of this artery and nerve has been fully described (p. 425). Observe now that they pass over the spine of the ischium, accompanied by the nerve to the obturator internus, and that in a thin subject it is possible to compress the artery against the spine. The rule for finding it is this: rotate the foot inwards, and draw a line from the top of the great trochanter to the base of the coccyx; the junction of the inner with the outer two-thirds gives the situation of the artery.*

POPLITEAL SPACE. ITS BOUNDARIES. It is advisable to examine the popliteal space at this stage of the dissection, in order that the various parts may be carefully made out with as little disturbance as possible of their mutual relations.

A vertical incision must be made along the middle of the ham, extending from six inches above, to three inches below the knee: transverse incisions should be made at each extremity of the vertical, so that the skin may be conveniently reflected. In doing so, care must be taken to preserve the cutaneous branch of the lesser ischiatic nerve, which descends over the space to the back of the leg.

The muscular fascia covering the space is very strong, and strengthened by numerous transverse fibres. It is pierced by the posterior saphena vein, which passes in to join the popliteal vein.

The fascia having been reflected, the muscles and tendons constituting the boundaries of the popliteal space are to be cleaned. The space is formed, above, by the divergence of the hamstring muscles to reach their respective insertions; below, by the con-

* Mr. Travers succeeded in arresting hæmorrhage from a sloughing ulcer of the glans penis by pressing the pudic artery with a cork against the spine of the ischium.

verging heads of the gastrocnemius: its shape is therefore that of a lozenge. It extends, above, as high as the lower third of the femur, and, below, as far as the upper sixth of the tibia. Above, it is bounded on the inner side by the semitendinosus, semimembranosus, gracilis, and sartorius; on the outer side, by the biceps; below, it is bounded on the inner side by the internal head of the gastrocnemius, on the outer, by the external head of this muscle and the plantaris.

The space is occupied by a quantity of fat, which permits the easy flexion of the knee; and in this fat are found the popliteal vessels and nerves, in the following order:—nearest to the surface are the nerves; the artery lies close to the bone, the vein being superficial to the artery (fig. 125).

GREAT ISCHIATIC NERVE. Along the outer border of the semimembranosus, and covered by the long head of the biceps, is the great ischiatic nerve, which, after giving off branches to the three great flexor muscles, divides, about the lower third of the thigh (higher or lower in different subjects), into two large nerves—the peroneal or external popliteal and the internal popliteal.

The *peroneal* nerve runs close by the inner side of the tendon of the biceps,* and subsequently in the groove between this muscle and the outer head of the gastrocnemius, towards the head of the fibula. As it passes round the joint it gives off *two articular* branches to the knee, which accompany the articular arteries, and a *recurrent articular* branch, which runs with the recurrent tibial artery to the front of the knee. It supplies also two or three *cutaneous branches* to the posterior and outer surfaces of the leg.

The *communicans peronei* (fig. 125) is a small branch given off as the nerve passes over the gastrocnemius; it joins the short saphenous which runs down the back of the calf, and behind the outer ankle, to supply the outer side of the foot and little toe.

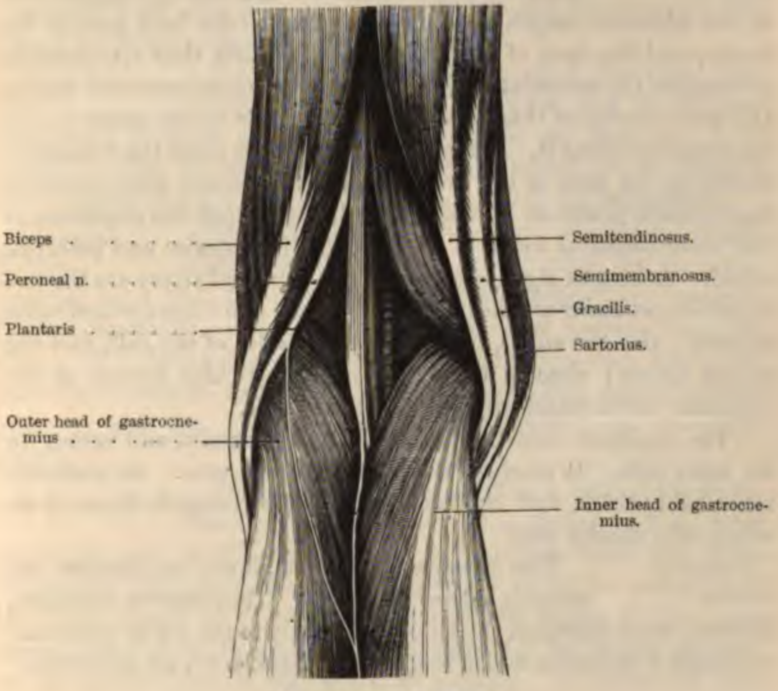
Below the head of the fibula we have already traced the divi

* The nerve is, therefore, very liable to be injured in the operation of dividing the outer hamstring. In the diagram, the nerve is not near enough to the tendon, their connections having been severed.

sion of the peroneal into the anterior tibial, and the musculo-cutaneous nerves (p. 532).

The *internal popliteal nerve* accompanies the popliteal artery, and, at the lower border of the popliteus, is continued under the name of the posterior tibial. The nerve in the popliteal space lies

Fig. 125.



LEFT POPLITEAL SPACE.

superficial to and rather external to the artery, and gives off *muscular branches* which supply the gastrocnemius, the plantaris, the soleus, and the popliteus; *three articular* branches, two accompanying the articular arteries, the third piercing the back of the capsule; and the *short saphenous*, which descends in the groove between the two heads of the gastrocnemius, about the middle of

the leg, is joined by the communicans peronei, and then, running down behind the outer malleolus in company with the short saphena vein, is distributed to the outer side of the little toe. The remainder of the nerve, as posterior tibial, supplies all the flexor muscles on the back of the leg and the sole of the foot.

POPLITEAL VESSELS. By clearing out all the fat, we observe that the popliteal vessels enter the ham through an aperture in the adductor magnus, and descend close to the back part of the femur, and the back of the knee-joint. At first they are partially overlapped (in muscular subjects) by the semimembranosus; indeed the outer border of this muscle is a good guide to the artery in the operation of tying it. The popliteal artery lies upon the triangular surface at the back of the lower third of the femur; then, upon the ligamentum posticum Winslowii; and, lastly, upon the popliteus, at the lower border of which it divides into the anterior and posterior tibial. Arising at right angles from the popliteal artery are the two *superior articular* arteries; lower down are two *inferior articular* arteries; also the *sural*, supplying the muscles of the calf, and the azygos artery; close to the vessel is the articular branch of the obturator nerve which supplies the knee-joint.

The popliteal *vein* lies superficial to the artery, and rather to its outer side. It receives the short saphena vein. Its coats are remarkably thick, and on transverse section resemble those of an artery of a similar size.

LYMPHATIC GLANDS. Two or more lymphatic glands are situated one on each side of the artery. They deserve attention, because, when enlarged, their close proximity to the artery may communicate a pulsation which might be mistaken for an aneurysm.

DISSECTION OF THE BACK OF THE THIGH.

The incision should be continued along the remainder of the back of the thigh, and the skin reflected.

CUTANEOUS NERVES AND VEINS. The skin at the back of the thigh is supplied by the *lesser ischiatic nerve*, which runs down beneath the fascia, as low as the upper third of the calf,

distributing branches on either side. On the outer side are seen a few cutaneous branches from the *posterior division* of the *external cutaneous* nerve.

The subcutaneous veins at the back of the thigh are very small: here they would be liable to pressure. But near the popliteal space there is a vein, called the *short saphena*. It comes up the back of the calf, and joins the popliteal vein after perforating the strong fascia covering the space.

MUSCULAR FASCIA. Respecting this, remark that its fibres run chiefly in a transverse direction, that it becomes stronger as it passes over the popliteal space, and that here it is connected with the tendons on either side. Remove it, to examine the powerful muscles which bend the leg, called the hamstrings.

HAMSTRING MUSCLES. There are three of these, and all arise by strong tendons from the tuber ischii. One, the biceps, is inserted into the head of the fibula; the other two—namely, the semitendinosus and semimembranosus—are inserted into the tibia. The divergence of these muscles towards their respective insertions occasions the space termed the *popliteal*, which is occupied by soft fat, the popliteal vessels, nerves, and lymphatic glands.

BICEPS. This muscle has two origins, a long and a short. The *long head arises*, by a strong tendon, from the back part of the tuber ischii in common with the semitendinosus; the *short head*, by fleshy fibres, from the outer lip of the linea aspera of the femur. This origin begins at the linea aspera, just below the insertion of the gluteus maximus, and continues nearly down to the external condyle. It joins the long head of the muscle, and both terminate on a common tendon, which is *inserted* into the head of the fibula, by two portions separated by the external lateral ligament of the knee-joint. It also gives off a strong expansion to the fascia of the leg. The tendon covers part of the external lateral ligament of the knee-joint, and a small bursa intervenes.

The biceps is not only a flexor of the leg, but rotates the leg, when bent, outwards. It is the muscle which in chronic disease

of the knee dislocates the leg outwards and backwards, and at the same time rotates it outwards. Each head of the biceps is supplied by the great ischiatic nerve. The short head is sometimes supplied by the peroneal.

SEMITENDINOSUS. This *arises*, in common with the biceps, from the back part of the tuber ischii. The fibres terminate upon a long round tendon, which rests upon the semimembranosus, and is *inserted* into the inner surface of the tibia by an expanded tendon, below the tendon of the gracilis, and behind that of the sartorius. Like them, it plays over the internal lateral ligament of the knee, and is provided with a bursa. Its nerve comes from the great ischiatic.

The semitendinosus sends off from the lower border of its tendon a very strong fascia to cover the leg, which is attached along the inner edge of the tibia. The middle of the muscle is intersected by an oblique tendinous line.

SEMIMEMBRANOSUS. This muscle *arises* from the tuber ischii above and external to the two preceding, by means of a strong flat tendon, which extends nearly half-way down the thigh. This tendon descends obliquely under the biceps and semitendinosus, and terminates in a bulky muscle, which lies on a deeper plane, and more internal, than the others, and is *inserted* by a thick tendon into the posterior part of the head of the tibia. In connection with the insertion of this tendon, notice, 1, that it is prolonged under the internal lateral ligament of the knee, and that a bursa intervenes between them; 2, that it sends a strong prolongation upwards and outwards to the external condyle of the femur, forming the principal portion of the *ligamentum posticum Winslowii*, which covers the back of the knee-joint; 3, that a dense fascia proceeds from its lower border, and binds down the popliteus; 4, that it is intimately connected with the semilunar cartilages of the joint, so as to keep them in place during its movements. Its nerve comes from the great ischiatic.

A large *bursa* is almost invariably found between the semimembranosus and the inner head of the gastrocnemius, where they rub one against the other. It is generally from one and a

half to two inches long. The chief point of interest concerning it is, that it occasionally communicates with the synovial membrane of the knee-joint, not directly, but through the medium of another bursa beneath the inner head of the gastrocnemius. From an examination of 150 bodies, it appears that this communication exists about once in five times; and it need scarcely be said that the proportion is large enough to make us cautious in interfering with this bursa when it becomes enlarged.*

Fig. 126.

Action of the Hamstring Muscles. These muscles produce two different effects, according as their fixed point is at the pelvis or the knee. With the fixed point at the pelvis, they bend the knee; with the fixed point at the knee, they take a very important part in maintaining the body erect. For instance, if, when standing, the body be bent at the hip and the muscles in question be felt, it will be found that they are in strong action, to prevent the trunk from falling forwards: they, too, are the chief agents concerned in bringing the body back again to the erect position. In doing this, they act upon a lever of the first order, as shown in fig. 126; the acetabulum being the fulcrum F, the trunk W, the weight to be moved, and the power P, at the tuber ischii.

To put the action of the muscles of the thigh on the pelvis in the clearest point of view, let us suppose we are standing upon one

* When the bursa in question becomes enlarged, it occasions a fluctuating swelling of greater or less dimensions on the inner side of the popliteal space. The swelling bulges out, and becomes tense and elastic when the knee is extended, and *vice versâ*. As to its shape, it is generally oblong; but this is subject to variety, for we know that the bursæ, when enlarged, are apt to become multilocular, and to burrow between the muscles where there is the least resistance.

leg: the bones of the lower extremity represent a pillar which supports the weight of the trunk on a ball-and-socket joint; the weight is nicely balanced on all sides, and prevented from falling by four groups of muscles. In front, are the rectus and sartorius; on the inner side, the adductors; on the outer side, the gluteus medius and minimus; behind, the hamstrings and gluteus maximus.

The semimembranosus can also rotate the knee inwards, thus assisting the popliteus.

The hamstring muscles are supplied with blood by the perforating branches of the profunda, which come through the tendon of the adductor magnus close to the femur. Their nerves are derived from the great ischiatic.

ISCHIATIC NERVE. This nerve descends from the gluteal region upon the adductor magnus, and, after being crossed by the long head of the biceps, runs along the outer border of the semimembranosus down the popliteal space. The further course of this nerve has already been described (p. 542).

Deferring the course, relations, and branches of the popliteal artery till this vessel is exposed throughout its whole course, pass on now to the dissection of the calf.

Continue the incision down the centre of the calf to the heel, and reflect the skin.

SHORT OR POSTERIOR SAPHENA VEIN. The large vein seen in the middle of the back of the leg is called the *short* or *posterior saphena*. It commences on the outer side of the foot, ascends behind the outer ankle, where it has a communication with the deep veins, and then runs up the calf between the two bellies of the gastrocnemius, receiving numerous veins in its course. It eventually passes through the muscular fascia, and joins the popliteal vein.

The chief cutaneous nerve of the calf is the short or posterior saphenous nerve; some branches, however, from the long saphenous and lesser ischiatic nerves are to be traced, ramifying in the subcutaneous tissue of the inner and upper part of the leg.

SHORT OR POSTERIOR SAPHENOUS NERVE. The *short saphenous* nerve* is derived from the popliteal (fig. 125), and passes down between the two heads of the gastrocnemius to the middle of the calf, where it pierces the fascia. Here it is joined by a branch from the peroneal nerve (*communicans peronei*); it then descends with the short saphena vein, and is finally distributed to the outer side of the foot and the little toe.

To expose the muscles of the calf, reflect the muscular fascia by incisions corresponding to those made through the skin.

MUSCLES OF THE CALF. The great flexor muscle of the foot consists of two portions: the superficial one, called the gastrocnemius, *arises* from the lower end of the femur; the deep one, called the soleus, arises from the tibia and fibula. The force of both is concentrated on one thick tendon, called the tendo Achillis, which is *inserted* into the os calcis.

GASTROCNEMIUS. This muscle *arises* by two strong tendinous heads, one from the upper and back part of each condyle of the femur (fig. 125). The inner head is the larger and longer. The two parts of the muscle descend, distinct from each other, and form the two bellies of the calf, of which the inner is rather the lower. Both *terminate*, rather below the middle of the leg, on the broad commencement of the tendo Achillis.

The gastrocnemius should be divided transversely near its insertion, and reflected upwards from the subjacent soleus, as high as its origin. By this proceeding you observe that the contiguous surfaces of the muscles are covered by a glistening tendon, which receives the insertion of their fibres, and transmits their collected force to the tendo Achillis.

Observe also the large sural vessels and nerves (branches of the popliteal) which enter the mesial aspect of each head of the muscle. To facilitate the play of the inner tendon over the condyle, there is a bursa, which generally communicates with the knee-joint; and in the substance of the outer tendon is commonly found a small

* This nerve is sometimes called the *communicans poplitei*, and does not take the name of short saphenous till its junction with the *communicans peronei*. (P. 542.)

piece of fibro-cartilage. Lastly, between the gastrocnemius and soleus is the tendon of the plantaris.

PLANTARIS. This small muscle * arises from the rough line just above the outer condyle of the femur and from the posterior ligament of the knee-joint. It descends close to the inner side of the outer head of the gastrocnemius, and terminates, a little below the knee, in a long tendon, which can be traced down the inner border of the tendo Achillis to the calcaneum. Its nerve comes from the internal popliteal.

SOLEUS. This muscle arises from the head and upper third of the posterior surface of the fibula, from the oblique ridge on the back of the tibia,† from about the middle third of the inner border of this bone, and from an aponeurotic arch thrown over the posterior tibial vessels. The muscular fibres bulge out beyond the gastrocnemius, and terminate on a broad tendon, which, gradually contracting, forms a constituent part of the tendo Achillis. The muscle lies upon the flexor longus digitorum, the tibialis posticus, the flexor longus pollicis, and the posterior tibial vessels and nerve. The soleus is supplied with blood by several branches from the posterior tibial; also by a large branch from the peroneal. Its nerve comes from the internal popliteal and enters the top of the muscle. This is an important muscle in a surgical point of view, for two reasons—1, by reflecting its tibial origin, we can reach the posterior tibial artery; 2, by reflecting its fibular origin we can reach the peroneal.

The *tendo Achillis* begins about the middle of the leg, and is at first of considerable breadth, but it gradually contracts and becomes thicker as it descends. The narrowest part of it is about one inch and a half above the heel; here, therefore, it can be most conveniently and safely divided for the relief of club-foot. There

* This is the representative of the palmaris longus of the forearm. In man it is lost on the calcaneum, but in monkeys, who have prehensile feet, it is the proper tensor muscle of the plantar fascia. It is remarkably strong in bears and plantigrade mammals.

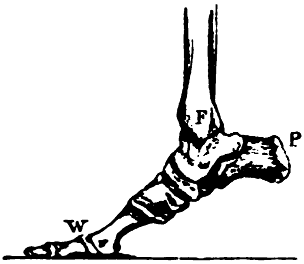
† The tibial and fibular origins of the soleus constitute what some anatomists describe as the two heads of the muscle. Between them descend the popliteal vessels, protected by a tendinous arch.

is no risk of injuring the deeper-seated parts, because they are separated from the tendon by a quantity of fat. Its insertion is into the under and back part of the tuberosity of the os calcis. The tendon previously expands a little: between it and the bone is a bursa of considerable size.

The *action* of the gastrocnemius and soleus is to raise the body on the toes. Since the gastrocnemius passes over two joints, it has the power (like the rectus) of extending the one while it bends the other, and it is, therefore, admirably adapted to the purpose of walking. For instance, by first extending the foot it raises the body, and then, by bending the knee, it transmits the weight from one leg to the other. Supposing the fixed point to be at the heel, the gastrocnemius is also concerned in keeping the body erect, for it keeps the tibia and fibula perpendicular on the foot, and thus counteracts the tendency of the body to fall forwards.

The tendo Achillis, in pointing the toes, acts upon a lever of the *first* order. The fulcrum is at the ankle-joint, F (fig. 127); the resistance, W, at the toes; the power at the heel, P. All the conditions are those of a lever of the first order. The power and the weight act in the *same* direction on *opposite* sides of the fulcrum. In raising the body on tiptoe, the tendo Achillis acts on a lever of the second order; the fulcrum being then at the ball of the great toe, and the weight of the body at the ankle.

Fig. 127.



Course and Relations of the Popliteal Artery. After passing through the opening in the tendon of the adductor magnus, the femoral artery takes the name of *popliteal*. It descends nearly perpendicularly behind the knee-joint, between the origins of the gastrocnemius, as far as the lower border of the popliteus, where it divides into the anterior and posterior tibial. In its descent it lies, first, upon the lower part of the femur, and here it is slightly overlapped by the semimembranosus; next, it

lies upon the posterior ligament of the knee-joint, and, lastly, upon the popliteus. At its lower part the artery is covered by the gastrocnemius and is crossed by the plantaris. The vein closely accompanies the artery, and is situated superficially with regard to it, and rather to its outer side in the first part of its course. The internal popliteal nerve runs also in a similar direction with the vein, but is still more superficial and to the outer side (fig. 125). The vessels and the nerve are surrounded by fat, and one or two lymphatic glands are generally found in the immediate neighbourhood of the artery, just above the joint.

The branches of the popliteal artery are the *articular* and the *sural*.

There are five *articular branches* for the supply of the knee-joint and the articular ends of the bone : the two *superior—external* and *internal*—run, one above each condyle, close to the bone; the two *inferior—external* and *internal*—run below the joint.

1. The *superior external articular* artery runs above the external condyle, passes beneath the biceps, and through the intermuscular septum : it then divides into a superficial and a deep branch; the superficial supplies the vastus externus, and then forms part of the patellar arterial plexus; the deep branch keeps close to the femur and supplies the joint.

2. The *superior internal articular* artery runs above the internal condyle, under the tendon of the adductor magnus and vastus internus, and divides into two branches, a superficial and a deep, which take a corresponding course to those on the outer side.

3. The *inferior external articular* artery runs under the gastrocnemius, over the popliteus, then, passing beneath the external lateral ligament and the tendon of the biceps, it reaches the patella, where it breaks up into branches anastomosing with the other articular arteries.

4. The *inferior internal articular* artery runs between the tuberosity of the tibia and the internal lateral ligament, and supplies the inner and anterior part of the joint.

5. The *azygos* artery is given off from the deep aspect of the popliteal, pierces the ligamentum posticum Winslowii, to supply the crucial ligaments and the synovial membrane.

The several articular arteries form over the front and sides of the joint a network of vessels which anastomose, superiorly, with the descending

branch of the external circumflex and the anastomotica magna; inferiorly, with the anterior tibial recurrent; and also among themselves. It is mainly through these channels that the collateral circulation is established in the leg after ligature of the superficial femoral.

The *sural arteries* proceed one to each head of the gastrocnemius, and are proportionate in size to the muscle; one or two branches are distributed to the soleus. These arteries are accompanied by branches of the internal popliteal nerve for the supply of the muscle.

Small *superior muscular* branches supply the vasti and hamstring muscles, and inosculate with the perforating and articular arteries.

POPLITEAL VEIN. This vein is formed by the junction of the venæ comites of the anterior and posterior tibial arteries, and is situated superficial to the artery. It crosses obliquely from the inner to the outer side of the artery, and is continued upwards as the femoral. It receives in the popliteal space the short saphena, the articular, and sural veins.

The insertion of the tendon of the semimembranosus into the head of the tibia, and its several connections, described (p. 546), should now be fully examined.

POPLITEUS. This muscle *arises* within the capsule of the knee-joint, from a depression on the outside of the external condyle by a thick tendon, which runs beneath the external lateral ligament. The muscular fibres gradually spread out, and are *inserted* into the triangular surface of the tibia above the soleal ridge on the bone. It is supplied by a branch of the popliteal nerve which enters its deep surface. Its action is to flex the leg, and then to rotate the tibia inwards. The tendon plays over the articulation between the tibia and fibula; and a bursa intervenes, which generally communicates by a wide opening with the knee-joint. The tendinous origin is in contact with the external semilunar cartilage.

Reflect the soleus from its origin, and remove it from the deep-seated muscles, observing at the same time the numerous arteries which enter its under surface. This done, notice the fascia which binds down the deep muscles. It is attached to the margin of the bones on either side, increases in strength towards the ankle, and

forms a *posterior annular* ligament which confines the tendons and the vessels and nerves in their passage into the sole of the foot.

DEEP MUSCLES ON THE BACK OF THE LEG. There are three :—the flexor longus digitorum on the tibial side; the flexor longus pollicis on the fibular; the tibialis posticus upon the interosseous membrane, between and beneath them both.

FLEXOR LONGUS DIGITORUM. This *arises* from the posterior surface of the tibia, commencing below the popliteus, and extending to within four inches of the lower end of the bone, also from the fascia over the tibialis posticus. The fibres terminate on a tendon which runs through a groove behind the inner ankle, and, entering the sole, divides into four tendons, which are inserted into the ungual phalanges of the four outer toes. It is supplied by the posterior tibial nerve.

FLEXOR LONGUS POLLICIS. This powerful muscle *arises* from the lower two-thirds of the posterior surface of the fibula, from the septum between it and the peronei, and from the aponeurosis over the tibialis posticus. The fibres terminate on a tendon which runs through a groove on the back of the astragalus; thence it passes under the sustentaculum tali, and is *inserted* into the ungual phalanx of the great toe. The chief action of this muscle is to raise the body on the tip of the great toe. It is essential to the propulsion of the body in walking. It is supplied by the posterior tibial nerve.

TIBIALIS POSTICUS. This is so concealed between the two preceding muscles that it cannot be properly examined without reflecting them. It *arises* from the interosseous membrane, from the opposite surfaces of the tibia and fibula for about their middle three-fifths, and from the aponeurosis covering it. In the lower part of the leg it passes between the tibia and the flexor longus digitorum. Its muscular fibres terminate on a tendon which comes into view a short distance above the inner ankle, and, running through the same groove with the tendon of the flexor longus digitorum, enters the sole, and is *inserted* into the scaphoid and internal cuneiform bones, and by fibrous prolongations into most of the tarsal and metatarsal bones. Its action is to bend

and turn the foot inwards. It is supplied by the posterior tibial nerve. The precise situation of the tendon of the tibialis posticus is interesting, surgically, because the tendon has to be divided for the relief of talipes varus. It lies close to, and parallel with, the inner edge of the tibia, so that this is the guide to it. It is necessary to relax the tendon, while the knife is introduced between the tendon and the bone. Its synovial sheath commences about 1½ inches above the end of the internal malleolus, and is consequently opened in the operation.

Attention should now be directed to the *internal* or *posterior annular ligament*, which binds down the tendons behind the inner ankle.

It is attached to the internal malleolus and the inner border of the os calcis. It is continuous above with the deep fascia, below with the plantar fascia. Beneath it pass the tendons of the deep-seated muscles of the leg into the sole of the foot. The relative positions of the structures passing under this ligament, proceeding from within outwards, are—the tendons of the tibialis posticus, and the flexor longus digitorum; the posterior tibial artery accompanied by its venæ comites; the posterior tibial nerve; and, lastly, the tendon of the flexor longus pollicis.

COURSE AND RELATIONS OF THE POSTERIOR TIBIAL ARTERY.

This artery is one of the branches into which the popliteal divides at the lower border of the popliteus. It descends over the deep muscles at the back of the leg to the interval between the internal malleolus and the os calcis, and, entering the sole, divides beneath the abductor pollicis into the external and internal plantar arteries. It lies, first, for a short distance, upon the tibialis posticus, then, on the flexor longus digitorum; but behind the ankle it is in contact with the tibia, so that here it can be felt beating, and effectually compressed. In the upper part of its course, it runs nearly midway between the bones, and is covered by the gastrocnemius and soleus: to tie it, therefore, in this situation, is difficult. But in the lower part of its course, it gradually approaches the inner border of the tibia, from which, generally speaking, it is not more than ½ or ¾ of an inch

distant. Here, being comparatively superficial, it may easily be tied. Immediately behind the internal malleolus, it lies between the tendons of the flexor longus digitorum on the inner side, and the flexor longus pollicis on the outer. It has two venæ comites, which communicate at intervals. The posterior tibial nerve which accompanies the artery is at first on its inner side, then crosses over it, and for the greater part of its course lies external to the artery. Its branches are as follows:—

a. Numerous *muscular* branches to the soleus and the deep muscles.

b. The *peroneal* is a branch of considerable size; often as large as the posterior tibial. Arising about an inch below the division of the popliteal, it descends close to the inner side of the fibula, and then over the articulation between the tibia and fibula to the outer part of the os calcis, where it inosculates with the malleolar and plantar arteries. All down the leg it is embedded among the muscles: being covered, first, by the soleus, afterwards by the flexor longus pollicis. To both these muscles, to the latter especially, it sends numerous branches, and just above the ankle it gives off a constant one—the *anterior peroneal*—which passes through the interosseous membrane to the under aspect of the peroneus tertius, then runs in front of the tibio-fibular articulation, and inosculates with the other malleolar and tarsal arteries. The peroneal supplies the *nutrient* artery of the fibula, and, about an inch above the os calcis, sends off a *transverse communicating* branch, which inosculates with the posterior tibial artery under the tendon of the flexor longus pollicis.

c. The *nutrient* artery of the tibia.

POSTERIOR TIBIAL NERVE. This is the continuation of the popliteal. It descends close to its corresponding artery, and, behind the inner ankle, divides into the external and internal plantar nerves. In the first part of its course the nerve lies superficial to the artery, and rather to its inner side; but lower down the nerve crosses the artery, and passes to its outer side. It supplies branches to the three deep-seated muscles, and a cutaneous branch—*calcaneo-plantar*—to the sole of the foot.

DISSECTION OF THE SOLE OF THE FOOT.

DISSECTION. Make a perpendicular incision down the middle of the sole, and reflect the skin. Notice the peculiar structure of the subcutaneous tissue. It is composed of globular masses of fat, separated by strong fibrous septa, and forms elastic pads, especially marked at the heel, and at the ball of the great and the little toes; these being the points which form the tripod supporting the arch of the foot.

In removing the subcutaneous tissue from the ball of the great and the little toes, we often meet with bursæ, simple or multilocular. They are generally placed between the skin and the sesamoid bones, and have remarkably thick walls. Frequently an artery and nerve can be traced running directly through one of these sacs, which explains the acute pain produced by their inflammation.

CUTANEOUS NERVES. The skin of the heel is supplied by the *calcaneo-plantar* branch of the posterior tibial nerve; the remainder of the sole by small branches of the plantar nerves which come through the fascia, as in the palm of the hand.

PLANTAR FASCIA. This is a remarkably dense white and glistening fascia. It extends from the under and back part of the os calcis to the distal extremities of the metatarsal bones. It is divided into a strong central and two lateral less dense portions; from which prolongations pass deeply inwards, separating the lateral from the central muscles. The *middle portion*, covering the flexor brevis digitorum, is narrow behind, and, as it passes forwards towards the toes, is spread out, and strengthened by transverse fibrous bands. The *inner portion* is comparatively thin, and surrounds the abductor pollicis, becoming continuous posteriorly with the internal annular ligament. The *outer portion* is thicker than the inner, especially as it passes forwards to be attached to the proximal end of the fifth metatarsal bone. It covers the abductor minimi digiti.

Near the distal ends of the metatarsal bones, the central part

divides into five portions; each of these subdivides into two slips, which embrace the corresponding flexor tendons, and are attached to the metatarsal bones and their connecting ligaments. Between the primary divisions of the fascia—that is, in a line between the toes—are seen the digital vessels and nerves. This arrangement is in all respects like that in the palm.

In the interdigital folds of the skin, there are also ligamentous fibres, which run from one side of the foot to the other, and answer the same purpose as those in the hand (p. 298).

The plantar fascia must be partially removed to examine the muscles. Towards the os calcis its removal is not accomplished without some difficulty, since the muscles arise from it.

SUPERFICIAL MUSCLES. After the removal of the fascia three muscles are exposed. All arise from the os calcis and the fascia, and proceed forwards to the toes.* The central one is the flexor brevis digitorum, the two lateral are the abductor pollicis, and the abductor minimi digiti.

ABDUCTOR POLLICIS. This muscle *arises* from the inner and back part of the os calcis, from the plantar fascia, and from the internal annular ligament. Its origin arches over the plantar vessels and nerves in their passage to the sole. The fibres run along the inner side of the sole, and terminate on a tendon which is *inserted* into the inner side of the base of the first phalanx of the great toe, through the medium of the internal sesamoid bone. Its nerve comes from the internal plantar.

ABDUCTOR MINIMI DIGITI. This muscle has a very strong *origin* from the under surface of the os calcis, from its external tubercle, from the plantar fascia, and from the external intermuscular septum. Some of its fibres terminate on a tendon which is inserted into the proximal end of the metatarsal bone of the little toe; but the greater part runs on to a tendon which is *inserted* into the outer side of the first phalanx of the little toe. It is supplied by the external plantar nerve.

* They are separated from each other by strong perpendicular partitions—intermuscular septa—which pass in from the plantar fascia.

FLEXOR BREVIS DIGITORUM. This muscle *arises* from the under surface of the os calcis, between the two preceding, from the plantar fascia and the intermuscular septa. It passes forwards and divides into four tendons, which run superficial to those of the long flexor. Cut open the sheath which contains them; follow them on to the toes, to see that each bifurcates over the first phalanx, to allow the long tendon to pass through; then the two slips, reuniting, are inserted into the sides of the second phalanx.

FIG. 128.

MUSCLES, VESSELS, AND NERVES OF THE SOLE OF THE RIGHT FOOT, AFTER REFLECTION OF THE FLEXOR BREVIS DIGITORUM.

The same arrangement prevails in the fingers. It is supplied by the internal plantar nerve.

The three superficial muscles should now be reflected, by sawing off about half an inch of the os calcis, and then turning it downwards with the muscles attached to it. This done, we bring into view the plantar vessels and nerves, the second layer of muscles—*i.e.* the long flexor tendon of the great toe, that of the other toes, and the flexor accessorius.

TENDON OF THE FLEXOR LONGUS DIGITORUM. MUSCULUS ACCESSORIUS.

Tracing this tendon into the sole, you find that an accessory muscle is attached to it. The *flexor accessorius arises* by muscular fibres from the inner side of the os calcis, and by tendinous fibres from the outer side in front of the external tubercle. Its fibres run straight forwards, and are *inserted* into the fibular side of the upper surface of the tendon, so that their action is not only to assist in bending the toes, but to make the common tendon pull in a straight line towards the heel; which from its oblique direction, it could not do without the accessory muscle. The common tendon then divides into four, one for each of the four outer toes. These run in the same sheath with the short tendons, and, after passing through their divisions, are inserted into the bases of the ungual phalanges. Respecting the manner in which the tendons are confined by fibrous sheaths, and lubricated by a synovial lining, what was said of the fingers (p. 304) applies equally to the toes. The flexor accessorius is supplied by the external plantar nerve.

LUMBRICALES.

These four little muscles are placed between the long flexor tendons. Each, excepting the most internal, *arises* from the adjacent sides of two tendons, proceeds forwards, and then, sinking between the toes, terminates in an aponeurosis which passes round the inner side of the four outer toes, and *joins* the extensor tendon on the dorsum of the first phalanges of the toes. Concerning their use, refer to p. 306. The two outer lumbricales are supplied by the external plantar nerve, the two inner by the internal.

Now trace the long flexor tendon of the great toe. From the groove in the astragalus it runs along the groove in the lesser tuberosity of the os calcis, above, that is nearer to the bones than the tendon of the flexor longus digitorum, and then straight to the base of the last phalanx. It crosses the long flexor tendon of the toes, and the two tendons are connected by an oblique slip; so that we cannot bend the other toes without the great toe.

PLANTAR ARTERIES.

The posterior tibial artery, having entered the sole between the origins of the abductor pollicis, divides into the external and internal plantar arteries.

The *internal plantar* artery is very small: it passes forwards between the abductor pollicis and the flexor brevis digitorum to the base of the great toe, and then is continued along the inner side of that toe, where it terminates in small inosculations with the digital arteries. Its chief use is to supply the muscles between which it runs.

The *external plantar* is the principal artery of the sole, and alone forms the plantar arch (fig. 129). It runs obliquely outwards across the sole towards the base of the fifth metatarsal bone; then, sinking deeply, it bends inwards across the bases of the metatarsal bones, and inosculates with the dorsalis pedis in the first interosseous space. At first it lies between the os calcis and the abductor pollicis; it then passes between the flexor brevis digitorum and the flexor accessorius; and, lastly, it lies deep beneath the flexor tendons, and the adductor pollicis, close to the metatarsal bones. Deeply seated as it appears to be, that part of its curve near the fifth metatarsal bone lies immediately beneath the fascia.

Fig. 129.

1. Internal plantar artery.
2. External do.

The external plantar sends a branch to the skin of the heel, and another round the outer edge of the foot; but its chief branches are the *four digital arteries*, which arise in the *deepest part* of its course. They supply both sides of the fifth, fourth, third, and the outer side of the second toe; the great toe, and the inside of the second, being supplied by the dorsalis hallucis. Concerning the ultimate distribution of the digital arteries, refer to the account given of these arteries in the hand (p. 300).

Besides the digital arteries, the arch gives off three small branches—the *perforating*—which ascend between the three outer interosseous spaces, and inosculate with the dorsal interosseous arteries at each end of the spaces.

PLANTAR NERVES. The posterior tibial nerve divides, like the artery, into an external and internal plantar. The *internal plantar* is the larger, and supplies nerves to the three inner toes and a half, like the median in the palm. It also supplies the muscles on the inner side of the sole, the abductor pollicis, the flexor brevis pollicis, the flexor brevis digitorum, and the two inner lumbricales; also articular branches to the tarsus and metatarsus. The *external plantar* nerve sends branches to the flexor accessorius and the abductor minimi digiti, and then divides into a superficial and deep branch. The *superficial* branch supplies the fifth toe and the outer side of the fourth toe (like the ulnar nerve in the palm), and the flexor brevis minimi digiti. The *deep* branch accompanies the plantar arch, and furnishes nerves to the two outer lumbricales, the adductor pollicis, the transversalis pedis, and all the interossei.

THIRD LAYER OF MUSCLES. Having traced the principal vessels and nerves, divide them with the flexor tendons near the os calcis, and turn them down toward the toes, to expose the deep muscles in the sole. These are, the flexor brevis and adductor pollicis, the flexor brevis minimi digiti, and the transversalis pedis.

FLEXOR BREVIS POLLICIS. This muscle *arises* by a flat tendon from the cuboid bone, and from the fibrous prolongation of the tibialis posticus into the external cuneiform. It proceeds along the metatarsal bone of the great toe, and divides into two portions, which run one on each side of the long flexor tendon, and are *inserted* by tendons into the sides of the first phalanx of the great toe. The inner tendon is inseparably connected with the abductor pollicis, the outer with the adductor pollicis. In each tendon there is a sesamoid bone. These bones not only increase the strength of the muscle, but, both together, form a pulley for the free play of the long flexor tendon; so that in walking the tendon is not pressed upon. Its nerve comes from the internal plantar.

ADDUCTOR POLLICIS. This very powerful muscle *arises* from the bases of the third and fourth metatarsal bones,

and from the sheath of the peroneus longus. Passing obliquely forwards and inwards across the foot, it is *inserted* through the external sesamoid bone into the outer side of the base of the first phalanx of the great toe together with the inner head of the flexor brevis. This muscle greatly contributes to support the arch of the foot. Like the adductor of the thumb it should be considered as an interosseous muscle. Its nerve is derived from the external plantar.

FLEXOR BREVIS MINIMI DIGITI. This little muscle *arises* from the base of the fifth metatarsal bone and the sheath of the peroneus longus, proceeds forward along the bone, and is *inserted* into the base of the first phalanx of the little toe. It is supplied by the external plantar nerve.

TRANSVERSALIS PEDIS. This slender muscle runs transversely across the distal ends of the metatarsal bones. It *arises* by little fleshy slips from the bases of the four outer toes, and is *inserted* into the first phalanx of the great toe with the adductor pollicis, of which it ought to be considered a part. Its nerve comes from the external plantar.

The fourth layer of muscles consists of the interossei.

INTEROSSEI. These muscles are arranged nearly like those in the hand. They occupy the intervals between the metatarsal bones, and are seven in number, four being on the dorsal aspect of the foot, three on the plantar. The four *dorsal interossei arise* each by two heads from the contiguous sides of the metatarsal bones, and are *inserted* into the bases of the first phalanges. The first is inserted into the inner side of the second toe; the remaining three into the outer sides of the second, third, and fourth. The *plantar interossei*, three in number, *arise* from the inner sides and under surfaces of the third, fourth, and fifth metatarsal bones, and are *inserted* respectively into the inner sides of the bases of the first phalanges of the third, fourth, and fifth toes.

The use of the interosseous muscles is to draw the toes to or from each other, and they do the one or the other according to the side of the phalanx on which they act. Now, if we draw a longi-

tudinal line through the second toe, we find that all the dorsal muscles draw *from* that line, and the plantar *towards* it. This is the key to the action of them all. A more detailed account of these muscles is given in the dissection of the hand (p. 336). Between the tendons of the interossei, that is, between the distal ends of the metatarsal bones, there are bursæ which facilitate movement. They sometimes become enlarged and occasion painful swellings between the roots of the toes. The flexor brevis minimi digiti, the transversalis pedis, and all the interossei are supplied by the external plantar nerve.

Now trace the tendons of the peroneus longus and tibialis posticus. The *tendon* of the *peroneus longus* is the deepest in the sole. It runs through a groove in the cuboid bone obliquely across the sole towards its insertion into the outer side of the base of the metatarsal bone of the great toe. It is confined in a strong fibrous sheath, lined throughout by synovial membrane.

The *tendon* of the *tibialis posticus* may be traced over the internal lateral ligament of the ankle, and thence under the head of the astragalus to the scaphoid bone, into which it is chiefly inserted. Prolongations are sent off to the cuneiform bones, to the cuboid, to the sustentaculum tali, and to the bases of the second, third, and fourth metatarsal bones. Observe that the tendon contributes to support the head of the astragalus, and that for this purpose it often contains a sesamoid bone. This is one of the many provisions for the solidity of the arch of the foot.

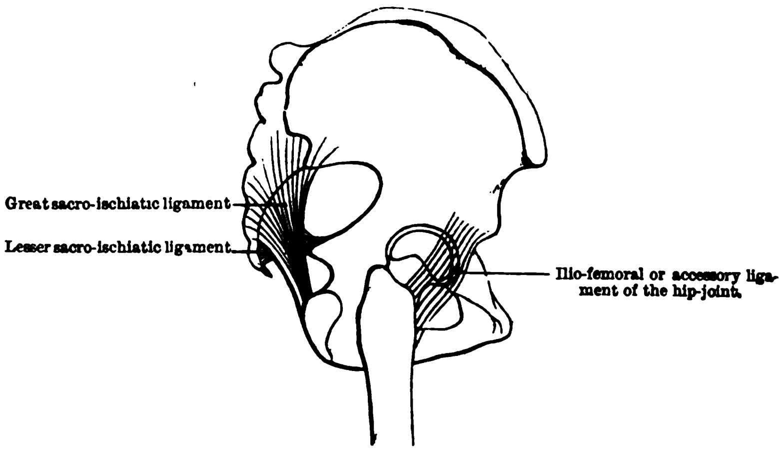
DISSECTION OF THE LIGAMENTS.

LIGAMENTS OF THE PELVIS. The sacrum is united to the last lumbar vertebra in the same manner as one vertebra is to another. The same observation applies to the union between the sacrum and the coccyx. The student should, therefore, refer to the description of the ligaments of the spine (p. 246).

The innominate bones are connected to each other in front, constituting the *symphysis pubis*; posteriorly to the sacrum, constituting the *sacro-iliac symphysis*.

PUBIC SYMPHYSIS. This is secured by, 1, an *anterior* ligament, consisting of irregular superficial fibres which run obliquely, and of deep fibres which pass transversely; 2, a *posterior* ligament, less distinct; 3, a *sub-pubic* ligament: it is very strong, and rounds off the point of the pubic arch; 4, a *superior* ligament which passes across the upper surface of the pubic bones; 5, an intermediate fibro-cartilage. A perpendicular section through it shows that it consists of concentric layers, and that its general structure resembles that between the bodies of the vertebræ. In the upper and back part of this fibro-cartilage is a

FIG. 130.



smooth cavity lined with epithelium. The cartilage acts like a buffer, and breaks the force of shocks passing through the pelvic arch.

The ilium is connected with the fifth lumbar vertebra by the *ilio-lumbar* ligament. It is very strong, and extends from the transverse process of the last lumbar vertebra to the crest of the ilium (fig. 131).

SACRO-ILIAC SYMPHYSIS. This is secured by, 1, an *anterior* ligament which consists of ligamentous fibres passing in front; 2, a *posterior* ligament, composed of fibres much stronger

and more marked, which pass behind the articulation. A well-marked fasciculus of fibres passes from the posterior superior spine to the third segment of the sacrum, and is called the *oblique sacro-iliac ligament.* The anterior part of the bones forming this articulation is crusted with articular cartilage, of which the shape is like that of the ear. Behind this is the strong *interosseous* ligament, which contributes powerfully to the security of the joint.

SACRO-ISCHIATIC LIGAMENTS. These are two strong ligaments passing from the sacrum to the ischium. The *great sacro-ischiatic* is triangular, and extends from the posterior inferior spine of the ilium, and the side of the sacrum and coccyx, to the tuberosity of the ischium. The *lesser sacro-ischiatic* ligament passes from the sacrum and coccyx to the spine of the ischium, where it narrows considerably. It lies anterior to the preceding ligament. These two ligaments not only connect the bones, but also, from their great breadth, contribute to diminish the lower aperture of the pelvis.

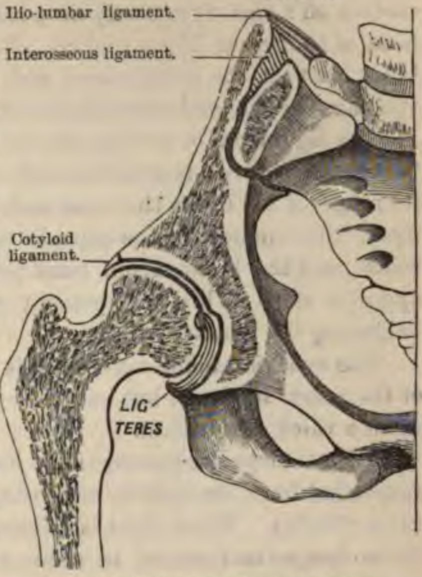
LIGAMENTS OF THE HIP-JOINT. This joint is secured by the form of the bones, and by the strength of the powerful muscles which surround it. Although a perfect ball-and-socket joint, its motion is somewhat limited: the disposition of its ligaments restricts its range of motion to those directions only which are most consistent with the maintenance of the erect attitude, and the requirements of this part of the skeleton.

CAPSULAR LIGAMENT. The *capsular* ligament is attached above to the circumference of the acetabulum, a little external to the margin, and also to the transverse ligament; below, to the inter-trochanteric ridge of the femur in front, and to the middle of the neck behind. The capsule is rendered exceedingly thick and strong in front by a broad ligament, *ilio-femoral,* which extends from the anterior inferior iliac spine, and then divides like the two arms of the inverted letter Y, one, the inner, passes to the lesser trochanter, the outer, to the upper part of the anterior inter-trochanteric ridge. This ligament is very strong,

serves as a strap to prevent the femur being extended beyond a certain point, and limits rotation inwards and outwards.

Open the capsule to ascertain its great thickness in front, and its strong attachment to the bones. This exposes the cotyloid ligament, and the ligamentum teres.

Fig. 131.



VERTICAL SECTION THROUGH THE HIP.

Ligamentum Teres. The ligamentum teres is exposed by drawing the head of the femur out of the socket. This ligament is somewhat flat and triangular. Its base, which is bifid, is attached, below, to the borders of the notch in the acetabulum; its apex, to the fossa in the head of the femur. To prevent pressure on it, and to allow free room for its play, there is a gap at the bottom of the acetabulum. This gap is not crusted with cartilage like the rest of the socket, but is occupied by soft fat. The ligamentum teres is surrounded by the synovial membrane. An artery runs up with it to the head of the femur. It is a branch of the obturator, and enters the acetabulum through the notch at the lower part.

The chief use of the ligamentum teres is to assist in steadying the pelvis on the thigh in the erect position. In this position, the ligament is vertical, and quite tight (fig. 131): it therefore prevents the pelvis from rolling towards the opposite side, or the thigh from being adducted beyond a certain point. Another purpose served by this ligament is to limit rotation of the thigh, both inwards and outwards.

COTYLOID LIGAMENT. The cotyloid ligament is a piece of fibro-cartilage which is attached all round the margin of the acetabulum. Its circumference is thicker than its free margin, which shelves off; thus it not only deepens the cavity, but embraces the head of the femur like a sucker. It extends over the notch at the lower part of the acetabulum, and in this situation has received the name of the *transverse* ligament.

The ligaments of the hip are so arranged that, when we stand 'at ease,' the pelvis is spontaneously thrown into a position in which its range of motion is the most restricted; for the accessory ligament (ilio-femoral) of the capsule prevents it from rolling backwards, and the ligamentum teres prevents its rolling towards the opposite side. This arrangement economises muscular force in balancing the trunk.

The synovial membrane extends down to the base of the neck of the femur in *front*, but only two-thirds down behind. It is laid upon a thick periosteum.

The atmospheric pressure is, of itself, sufficient to keep the limb suspended from the pelvis, supposing all muscles and ligaments to be divided. When fluid is effused into the hip-joint, the bones are no longer maintained in accurate contact; and it sometimes happens that the head of the femur escapes from its cavity, giving rise to a spontaneous dislocation.

LIGAMENTS OF THE KNEE-JOINT. The knee is a hinge-joint, and, looking at the skeleton, one would suppose that it was very insecure. But this insecurity is only apparent; the joint being surrounded by powerful ligaments, and a thick capsule formed by the tendons of the muscles which act upon it.

First examine the tendons concerned in the protection of the knee-joint. In front is the ligamentum patellæ; on either side are the tendons of the vasti; at the back of the joint are four tendons—namely, the tendons of the gastrocnemius, the tendon of the semimembranosus, and of the popliteus. It deserves to be noticed that the weakest part of the joint is near the tendon of the popliteus: here, therefore, pus formed in the popliteal space may make its way into the joint, or *vice versâ*.

The proper ligaments of the joint are—1, the *lateral*; 2, the *crucial* in the interior.

INTERNAL LATERAL LIGAMENT. This is a broad flat band, which extends from the inner condyle of the femur to the inner side of the tibia, a little below its head (fig. 132). A few of the deeper fibres are attached to the inner semi-lunar cartilage, and serve to keep it in place. The inferior internal articular artery, and part of the tendon of the semimembranosus, pass underneath this ligament. In the several motions of the joint, there is a certain amount of friction between the ligament and the head of the tibia, and consequently a small bursa is interposed.

FIG. 132.

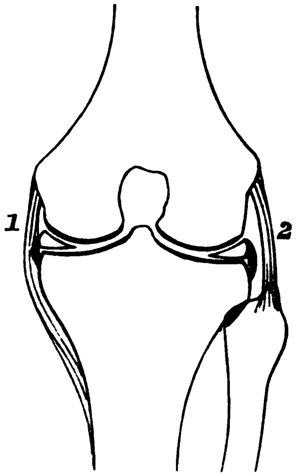


DIAGRAM OF THE SEMI-LUNAR CARTILAGES AND LATERAL LIGAMENTS OF THE KNEE.
1. Internal lateral ligament.
2. External ditto.

EXTERNAL LATERAL LIGAMENT. This is a strong round band, which extends from the outer condyle of the femur to the head of the fibula. This ligament separates the two divisions of the tendinous insertion of the biceps. Posterior to, and running parallel with, the external lateral ligament is a smaller band of fibres, called the *short external lateral* ligament.

POSTERIOR LIGAMENT. This, which is generally called '*ligamentum posticum Winslowii*,' consists of expansions derived from the tendons at the back of the joint, chiefly, however, from the semimembranosus (p. 546). It extends from the posterior part of the tuberosity of the tibia to the outer condyle of the femur. It not only closes and protects the joint behind, but prevents its extension beyond the perpendicular.

The joint should be opened above the patella. Observe the great extent of the fold which the synovial membrane forms above this bone.* It allows the free play of the bone over the lower part

* In performing operations near the knee, the joint should always be bent, in order to draw the synovial fold as much as possible out of the way.

of the femur. The fold extends higher above the inner than the outer condyle, which accounts for the form of the swelling produced by effusion into the joint.

FOLDS OF SYNOVIAL MEMBRANE.

Below the patella a slender band of the synovial membrane proceeds backwards to the space between the condyles, and is called the *ligamentum mucosum*. Two similar horizontal folds are termed the *ligamenta alaria*. These are not true ligaments, but merely remnants of the partition which, in the early stage of the joint's growth, divided it into two halves.

Outside the synovial membrane there is always fat; especially under the ligamentum patellæ. Its use is to fill up vacuities, and to mould itself to the several movements of the joint.

CRUCIAL LIGAMENTS.

The crucial ligaments, so named because they cross like the letter X, extend from the mesial side of each condyle to the head of the tibia. The *anterior* or *external*, the smaller, ascends from the inner part of the fossa in front of the spine of the tibia, backwards and outwards to the inner and back part of the external condyle. The *posterior* or *internal*, best seen from behind, extends from the back of the fossa behind the spine of the tibia forwards to the front of the inner condyle.

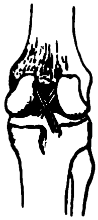
INTER-ARTICULAR OR SEMI-LUNAR CARTILAGES.

Between the condyles and the articular surfaces of the tibia are two incomplete rings of fibro-cartilage, shaped like the letter C. They serve to deepen the articular surfaces of the tibia; their mobility and flexibility enable them to adapt themselves to the condyles in the several movements of the joint; they distribute pressure over a greater surface and break shocks. They are thickest at the circumference, and gradually shelve off to a thin margin: thus they fit in between the bones, and adapt a convex surface to a flat one, as shown in fig. 132. Their form is suited to the condyles, the inner being oval, the outer circular, and the synovial membrane covers both surfaces of the cartilages. The ends of each are firmly attached by ligaments to the pits in front and behind the spine of the tibia; but the ends of the external one

lie within those of the internal which are attached further from the spine. The cartilages are connected in front by a thin *transverse* ligament; and their circumference is attached round the head of the tibia by fibrous tissue, called the *coronary ligament* (seen in fig. 132), yet not so closely as to restrict their range of motion.*

ACTION OF THE LIGAMENTS. Their respective points of attachment are such that, when the joint is extended, all the ligaments are tight, to prevent extension beyond the perpendicular; thus muscular force is economised. But when the joint is bent the ligaments are relaxed, enough to admit a slight rotatory movement of the tibia. This movement is more free outwards than inwards; and is effected, not by rotation of the tibia on its own axis, but by rotation of the outer head round the inner. Rotation outwards is produced by the biceps; rotation inwards by the popliteus and semimembranosus.

FIG. 133.



CRUCIAL LIGAMENTS OF THE KNEE.

The crucial ligaments, though placed inside the joint, answer the same purposes as the coronoid process and the olecranon of the elbow. They make the tibia *slide* properly forwards and backwards. In extension, the anterior crucial ligament is tight; in flexion, the posterior ligament becomes tight and consequently limits flexion. They also conjointly limit excessive rotation. They not only prevent dislocation in front or behind, but they prevent lateral displacement, since they cross each other like braces, as shown in fig. 133.

SUPERIOR TIBIO-FIBULAR JOINT. There is a joint between the tibia and fibula at their upper and lower extremities. The upper joint is secured by an *anterior* and a *posterior tibio-fibular ligament*; their fibres are very strong and run in an oblique direction downwards and outwards, passing from the external tuberosity of the tibia to the head of the fibula. The

* Of the two cartilages the external has the greater freedom of motion, because in rotation of the knee the outer side of the tibia moves more than the inner. Consequently, it is not in any way connected to the external lateral ligament; so far from this, it is separated from it by the tendon of the popliteus, of which the play is facilitated by a bursa communicating freely with the joint. For this reason the external cartilage is more liable to dislocation than the internal.

contiguous surfaces of the bones are crusted with cartilage. In the large majority of instances the synovial membrane is a separate one, but it occasionally communicates with the synovial membrane of the knee-joint.

INTEROSSEOUS MEMBRANE. The contiguous borders of the tibia and fibula are connected by the interosseous membrane. The purpose of it is to afford additional surface for the attachment of muscles. Its fibres pass chiefly downwards and outwards from the tibia to the fibula, but a few fibres cross like the letter X. The anterior tibial artery comes forwards above the interosseous membrane, through an oval space about an inch below the head of the fibula. Lower down there is an aperture for the anterior peroneal artery. It is moreover pierced here and there by small blood-vessels.

INFERIOR TIBIO-FIBULAR JOINT. The lower extremities of the tibia and fibula are firmly connected, for it is essential to the security of the ankle-joint that there should be little or no movement between the two bones. The *anterior ligament* is composed of oblique fibres which pass downwards from the tibia to the fibula; the *posterior ligament* is stronger and narrower than the anterior, and its fibres pass horizontally from the outer malleolus to the posterior border of the tibia, above the articular surface. The *inferior interosseous ligament* connects the contiguous surfaces of the two bones. The synovial membrane of this joint is an extension upwards of that of the ankle-joint.

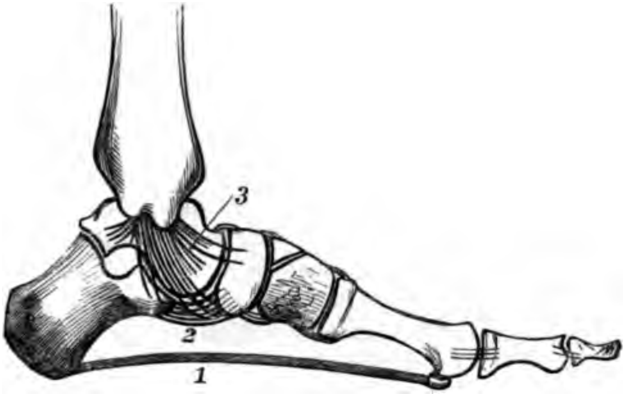
LIGAMENTS OF THE ANKLE-JOINT. From the form of the bones, it is obvious that the ankle is a hinge-joint; consequently, its security depends upon the great strength of its lateral ligaments. The hinge, however, is not so perfect but that it admits of a slight rotatory motion, of which the centre is on the fibular side, and therefore the reverse of that in the case of the knee.

INTERNAL LATERAL LIGAMENT. This ligament, sometimes called, from its shape, *deltoid*, is exceedingly thick and strong, and compensates for the comparative shortness of the

malleolus on this side (fig. 134). The great strength of it is proved by the fact that, in dislocations of the ankle inwards, the summit of the malleolus is more often broken off than the ligament torn. It extends from a deep excavation at the apex of the malleolus, radiates from this point, and is attached to the side of the astragalus, also to the os calcis, to the scaphoid bone, and to the inferior calcaneo-scaphoid ligament, which it firmly braces up (fig. 134).

EXTERNAL LATERAL LIGAMENT. This ligament consists of three distinct fasciculi —an *anterior*, a *posterior*, and a *middle* (fig. 135). All three arise from surfaces near the summit of

FIG. 134.



1. Plantar fascia.
2. Calcaneo-scaphoid ligament which supports the head of the astragalus.
3. Internal lateral ligament, called from its shape deltoid.

the external malleolus; the first two are inserted into the front and the back of the astragalus respectively; the middle into the outer surface of the os calcis.

ANTERIOR AND POSTERIOR LIGAMENTS. The closure of the joint is completed, in front and behind, by an *anterior* and a *posterior ligament* attached to the bones near their articular surfaces, and sufficiently loose to permit the necessary range of motion.

Besides flexion and extension, the ankle-joint admits of a

slight lateral movement, only permitted in the extended state, for the better direction of our steps. In adaptation to this movement the internal malleolus is shorter than the outer; it is not so tightly confined by its ligaments, and its articular surface is part of a cylinder.

Fig. 135.

DIAGRAM OF THE EXTERNAL LATERAL LIGAMENT.

1. Anterior part.
2. Posterior part.
3. Middle part.
4. Interosseous ligament between the astragalus and os calcis.

Open the joint to see that the breadth of the articular surfaces of the bones is greater in front than behind. The object of this is to render the astragalus less liable to be dislocated backwards. Whenever this happens, the astragalus must of necessity become firmly locked between the malleoli.

LIGAMENTS CONNECTING THE BONES OF THE FOOT.

The astragalus is the key-stone of the arch of the foot, and supports the whole weight of the body. It articulates with the os calcis and the os scaphoides in such a manner as to permit the abduction and adduction of the foot, so useful in the direction of our steps.

ASTRAGALO-CALCANEAL LIGAMENTS.

The astragalus articulates with the os calcis, by two distinct surfaces separated by the interosseous groove, of which the anterior is convex, the posterior slightly concave. The *interosseous ligament* descends vertically in the interosseous canal, and is the principal bond of union between the two bones. The *posterior ligament* is a short oblique band, which passes from the posterior border of the astragalus to the upper border of the os calcis. The *external ligament* passes vertically from the astragalus to the os calcis.

ASTRAGALO-SCAPHOID LIGAMENT.

The anterior surface of the astragalus is broadly convex, fitting into the concave surface of the scaphoid. Superiorly, the surfaces of the two bones are connected by a broad ligament, *astragalo-scaphoid*, which blends with the external calcaneo-scaphoid.

CALCANEO-SCAPHOID LIGAMENT. In the skeleton the head of the astragalus articulates in front with the scaphoid, but the lower part of it is unsupported. This interval is bridged over by a very strong and slightly elastic ligament, which extends from the os calcis to the scaphoid (fig. 134). These bones, together with the ligament, form a complete socket for the head of the astragalus; it is this joint, chiefly, which permits the abduction and adduction of the foot. The ligament being slightly elastic, allows the keystone of the arch (the astragalus) a play, which is of great service in preventing concussion of the body. Whenever this ligament yields, the head of the astragalus falls, and the individual becomes gradually flat-footed.

The ligament is thick and strong, and passes horizontally forwards from the sustentaculum tali to the plantar surface of the scaphoid, where it is connected with the tendon of the tibialis posticus, and, superiorly, with the astragalo-scaphoid ligament. The *external calcaneo-scaphoid ligament* is short, lying in the hollow between the astragalus and os calcis, and passes from the ridge on the anterior part of the os calcis to the outer side of the scaphoid.

FIG. 136.

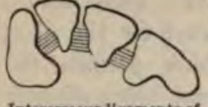
1. Calcaneo-scaphoid ligament.
2. Calcaneo-cuboid ligament.

CALCANEO-CUBOID JOINT. The os calcis articulates with the os cuboides nearly on a line with the joint between the astragalus and the scaphoid. The bones are firmly connected by the *inferior calcaneo-cuboid ligament*, of which the superficial portion, the *ligamentum longum plantæ*, is attached to the os calcis as far as the tubercle, and passes forwards to the plantar aspect of the cuboid; some of its fibres extend to the second, third, and fourth metatarsal bones, and complete the canal for the tendon of the peroneus longus. The *ligamentum breve plantæ* is very broad, and passes from the os calcis to the inner side of the cuboid bone.

The *dorsal ligament* connects the upper surfaces of the bones.

The remaining bones of the tarsus are connected and maintained in position by *dorsal* and *plantar ligaments*, and strong *interosseous bands* which pass between their contiguous surfaces.

Fig. 137.



Interosseous ligaments of the wedge bones.

Though there is very little motion between any two bones, the collective amount is such that the foot is enabled to adapt itself accurately to the ground; pressure is more equally distributed, and consequently there is a firmer basis for the support of the body. Being composed, moreover, of several pieces, each of which possesses a certain

Fig. 138.

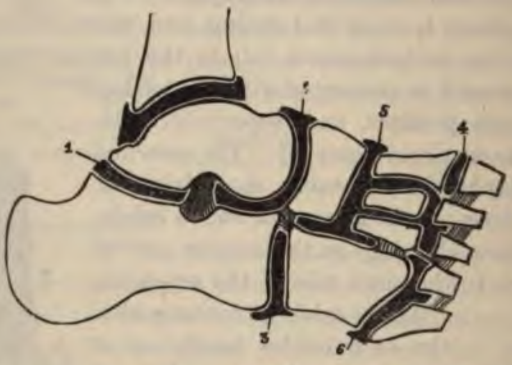


DIAGRAM OF THE ARTICULATIONS OF THE TARSUS AND THE TARSO-METATARSUS.

1. Posterior calcaneo-astragaloid synovial cavity.
2. Calcaneo-scaphoid synovial cavity.
3. Calcaneo-cuboid synovial cavity.
4. Synovial cavity between metatarsal bone of great toe, and internal cuneiform bone.
5. Common scapho-cuneiform, intercuneiform, and metatarso-cuneiform synovial cavity.
6. Cubo-metatarsal synovial cavity.

elasticity, the foot gains a general springiness and strength which could not have resulted from a single bone.

TARSO-METATARSAL JOINTS. The tarsus articulates with the metatarsus in an oblique line which inclines backwards on its outer side. This line is interrupted at the joint of the middle cuneiform bone and the second metatarsal bone. Here there is a deep recess, so that the base of this metatarsal bone is wedged in between the internal and external cuneiform bones.

These joints are maintained in position, above, by *dorsal tarso-metatarsal ligaments*, and, below, by *plantar ligaments*. *Inter-osseous ligaments* also pass between the wedge bones, keeping them in their respective places (fig. 137).

The metatarsal bones are connected to those at their proximal and distal ends by *dorsal* and *plantar ligaments*: those at the proximal extremities are very strong, and are supplemented by *interosseous fibres*, as in the metacarpus, p. 350.

The distal extremities of the metatarsal bones are united by the *transverse metatarsal ligament*; this extends from the great to the little toe on their plantar surfaces.

Synovial Membranes of the Tarsus. Exclusive of the ankle-joint and the phalanges of the toes, the bones of the foot are provided with six distinct synovial membranes; namely—

1. Between the posterior articular surface of the os calcis and that of the astragalus.

2. Between the head of the astragalus and the scaphoid, and between the anterior articular surface of the astragalus and os calcis.

3. Between the os calcis and the os cuboides.

4. Between the inner cuneiform bone and the metatarsal bone of the great toe.

5. Between the scaphoid and the three cuneiform bones, and between these and the adjoining bones (the great toe excepted).

6. Between the os cuboides and the fourth and fifth metatarsal bones.

The joints formed between the distal ends of the metatarsal bones and the phalanges of the toes, and the several inter-phalangeal joints, are connected in all respects like those of the fingers. See the description given in the dissection of the hand (p. 351).

DISSECTION OF THE BRAIN.

MEMBRANES OF THE BRAIN. PREVIOUS to the examination of the brain itself, we should study the structure and uses of the three membranes by which it is surrounded.

The first, the *dura mater*, has been described (p. 6). The second is a serous membrane, termed the *arachnoid* ; the third is a vascular one, termed the *pia mater*.

ARACHNOID MEMBRANE. This second investment forms the smooth, polished surface of the brain, exposed after the removal of the dura mater. It is named *arachnoid*, from the resemblance of its texture to a spider's web. It is a serous membrane, and, like all others of the kind, forms a closed sac, one part of which, the *parietal layer*, lines the under surface of the dura mater; the other, the *visceral*, is reflected over the brain.

The opposed surfaces of this membrane are polished, and lubricated by a serous fluid which diminishes friction; since the brain is moved with a slight pulsation, caused in part by the action of the heart, in part by respiration. The *parietal* layer is so thin that it can be demonstrated as a distinct layer only in a few places; it consists of little more than a layer of squamous epithelium, lining the inner aspect of the dura mater. The *visceral* layer is colourless and transparent ; it is spread uniformly over the surface of the brain, and does not dip into the furrows between the convolutions. On account of its extreme tenuity, and its close adhesion to the pia mater, it cannot be readily separated from this membrane; but there are places, especially at the base of the brain, termed *subarachnoid spaces*, where the arachnoid membrane can be seen distinct from the subjacent pia mater.

SUBARACHNOID SPACES AND FLUID. Wherever the arachnoid membrane is separated from the pia mater a serous fluid (*cerebro-spinal*) intervenes, contained in the meshes of a very delicate areolar tissue. The spaces between them are termed *subarachnoid.* They are very manifest in some places. For instance, there is one well-marked space in the longitudinal fissure, where the arachnoid does not descend to the bottom, but passes across the edge of the falx cerebri, a little above the corpus callosum. At the base of the brain, there are two of considerable size: one is situated between the anterior border of the pons Varolii and the commissure of the optic nerves; the other between the cerebellum and the medulla oblongata. In the spinal cord, also, there is a considerable interval occupied by fluid between the arachnoid and the pia mater. The purpose of this fluid is, not only to fill up space, as fat does in other parts, but mechanically to protect the nervous centres from the violent shocks and vibrations to which they would otherwise be liable.

The brain therefore may be said to be supported in a fluid, which insinuates itself into all the inequalities of the surface, and surrounds all the nerves as far as the foramina, through which they pass. This fluid sometimes escapes through the ear, in cases of fracture through the base of the skull, involving the meatus auditorius internus and the petrous portion of the temporal bone.*

PIA MATER. This, the immediate investing membrane of the brain, is extremely vascular, and composed of a minute network of blood-vessels held together by delicate connective tissue. From its internal surface vessels pass off at right angles into the interior of the brain. The pia mater dips into the fissures between the convolutions, and penetrates into the ventricles for the supply of their interior, forming the *velum interpositum* and the *choroid plexuses.*†

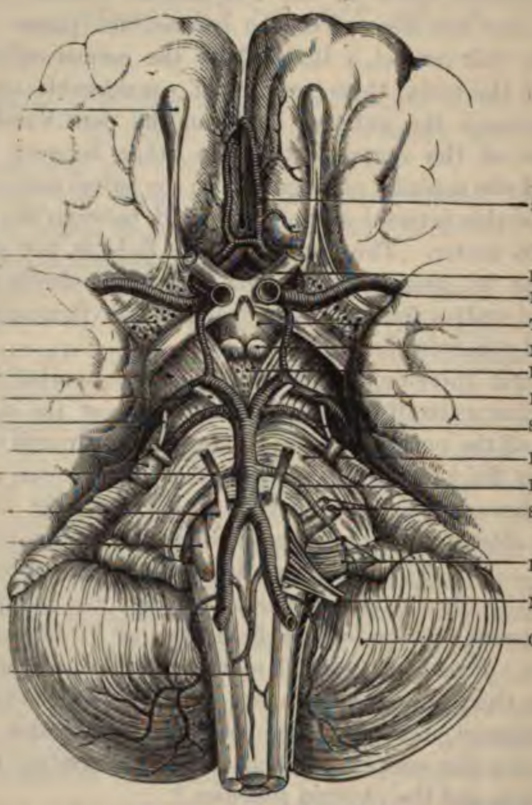
* The cerebro-spinal fluid varies in amount from two drachms to two ounces. It is a clear, limpid fluid, slightly alkaline, containing 98·5 parts of water, and 1·5 parts of solid matter. The cerebro-spinal fluid of the encephalon and that of the spinal cord communicate.

† The arachnoid is said to be supplied with filaments from the motor root of the fifth, the facial and the spinal accessory nerves; the pia mater by the third, sixth, facial, pneumogastric, spinal accessory and sympathetic nerves.

ARTERIES OF THE BRAIN. The brain is supplied with blood by the two internal carotid and the two vertebral arteries.

INTERNAL CAROTID. This artery enters the skull through the carotid canal in the temporal bone, and ascends very

FIG. 139.



tortuously by the side of the body of the sphenoid, along the inner wall of the cavernous sinus. It appears on the inner side of the anterior clinoid process, and, after giving off the ophthalmic, divides into the anterior and middle cerebral and posterior communicating arteries.

a. The *anterior cerebral* artery passes forwards to reach the longitudinal fissure between the hemispheres, curves round the front part of the corpus callosum, then runs backwards along its upper surface (under the name of the *artery of the corpus callosum*), and terminates in branches which anastomose with the posterior cerebral. The anterior cerebral arteries of opposite sides run close together; and at the base of the brain are connected by a transverse branch, called the *anterior communicating artery* (fig. 139).

b. The *middle cerebral* artery, the largest branch of the internal carotid, runs deeply within the fissure of Sylvius, and divides into many branches, distributed to the anterior and middle lobes. Near its origin it gives off a multitude of small arteries, which pierce the locus perforatus anticus to supply the corpus striatum.

c. The *posterior communicating* artery proceeds directly backwards to join the posterior cerebral; thus establishing at the base of the brain the free arterial inosculation called the *circle of Willis.*

d. The *anterior choroid* artery, a small branch of the internal carotid, arises external to the posterior communicating artery. It runs backwards, and enters the fissure at the bottom of the middle horn of the lateral ventricle, to terminate in the choroid plexus of that cavity.

VERTEBRAL ARTERY. This artery, a branch of the subclavian in the first part of its course, winds backwards along the arch of the atlas, and enters the skull through the foramen magnum by perforating the posterior occipito-atlantoïd ligament. It then curves round the medulla oblongata between the hypoglossal nerve and the anterior root of the first cervical. At the lower border of the pons Varolii, the two arteries unite to form a single trunk —the '*basilar*'—which is lodged in the groove along the middle of the pons, and bifurcates at its upper border into the posterior cerebral arteries.

Each vertebral artery, before joining its fellow, gives off—

a. A *posterior meningeal* branch, distributed to the posterior fossa of the skull.

b. *Anterior* and *posterior spinal* arteries, which run along the median fissures of the front and back surfaces of the spinal cord.

c. The *inferior cerebellar* artery, sometimes a branch of the basilar, but more frequently of the vertebral, passes backwards between the hypo-

glossal and pneumogastric nerves, and divides into two branches, which are distributed to the inferior surface of the cerebellum.

The *basilar* artery, formed by the junction of the two vertebral, in its course along the pons gives off on each side—

a. Transverse branches which pass outwards on the pons: one, the *auditory*, enters the meatus auditorius internus with the auditory nerve, to be distributed to the internal ear.

b. The *anterior cerebellar*, which supplies the front part of the lower surface of the cerebellum and anastomoses with the other cerebellar arteries.

c. The *superior cerebellar*, which is distributed to the upper surface of the cerebellum; the valve of Vieussens and part of the velum interpositum.

d. The two *posterior cerebral*, the terminal branches into which the basilar artery divides, run outwards and backwards, in front of the third nerve. They wind round the crura cerebri and divide into numerous branches which supply the under surface of the posterior cerebral lobes, and ultimately inosculate with the other cerebral arteries. Each gives off a small *posterior choroid artery*, distributed to the velum interpositum, and choroid plexus.

CIRCLE OF WILLIS. This important arterial inosculation (fig. 139) is formed, laterally, by the two anterior cerebral, the two internal carotid, and the two posterior communicating arteries; in front, it is completed by the anterior communicating artery; behind, by the two posterior cerebral. The tortuosity of the large arteries before they enter the brain serves to mitigate the force of the heart's action; and the circle of Willis provides a free supply of blood from other vessels, in case any accidental circumstance should stop the flow of blood through any of the more direct channels.*

* In many of the long-necked herbivorous quadrupeds a provision has been made in the disposition of the internal carotid arteries, for the purpose of equalising the force of the blood supplied to the brain. The arteries, as they enter the skull, divide into several branches, which again unite and form a remarkable network of arteries, called by Galen, who first described it, the '*rete mirabile*.' The object of this evidently is to moderate the rapidity with which the blood would otherwise enter the cranium in the different positions of the head, and thus preserve the brain from those sudden influxions to which it would under other circumstances be continually exposed.

PECULIARITIES OF THE CEREBRAL CIRCULATION. Besides the circle of Willis, there are other peculiarities relating to the circulation of the blood in the brain: namely, the length and tortuosity of the four great arteries as they enter the skull; their passage through tortuous bony canals; the spreading of their ramifications in a very delicate membrane, the pia mater, before they enter the substance of the brain; the minuteness of the capillaries, and the extreme thinness of their walls; the formation of the venous sinuses (p. 8), which do not accompany the arteries; the chordæ Willisii in the superior longitudinal sinus; the absence of valves in the sinuses; and the confluence of no less than six sinuses, forming the *torcular Herophyli*, at the internal occipital protuberance.

GENERAL DIVISION OF THE BRAIN. The mass of nervous substance contained within the cranium, comprised under the common term brain (encephalon), is divided into four parts: the *cerebrum*, which occupies the whole of the upper part of the cranial cavity; the *cerebellum*, or smaller brain, which occupies the space below the tentorium cerebelli; the *pons Varolii*, or the quadrilateral mass of white fibres which rests upon the basilar process of the occipital bone; and the *medulla oblongata*, situated below the pons, and continuous with the spinal cord (fig. 142).

The weight of the entire encephalon bears a proportionate relation to the intellectual power. The result of observations shows that it averages in males about 50 ounces, and in females about 44 ounces.

MEDULLA OBLONGATA. This term is applied to that part of the cerebro-spinal axis which is placed below the pons Varolii, and is continuous with the spinal cord on a level with the upper border of the atlas. It is slightly pyramidal in shape, with the broad part above. It lies on the basilar groove of the occipital bone, and descends obliquely backwards through the foramen magnum. Its posterior surface is received into the fossa (vallecula) between the hemispheres of the cerebellum. It is about an inch and a quarter in length, and nearly an inch thick at its broadest part.

In front and behind, the medulla is marked by a median

fissure, the *anterior* and *posterior median fissures*, which are the continuations of the median fissures of the spinal cord. The anterior ends, below the pons Varolii, in a cul-de-sac, termed the *foramen cœcum*, and is occupied by a process of pia mater. The posterior runs along the floor of the fourth ventricle as a shallow median groove.

The surface of the medulla is marked out on each side into four longitudinal columns, which receive the following names

Fig. 140.

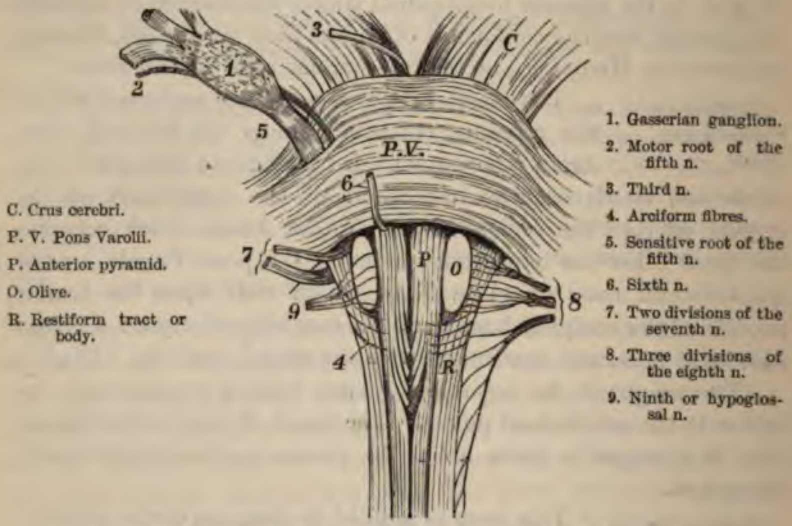


DIAGRAM OF THE FRONT SURFACE OF THE MEDULLA OBLONGATA.

from before backwards: the *anterior pyramids*, the *olivary bodies*, the *restiform bodies*, and the *posterior pyramids*.

The *anterior pyramids* are two columns of white matter, narrow below, but increasing gradually in breadth as they ascend towards the pons. At this part they become constricted, and may be traced through the pons into the crura cerebri. The fibres of which they are in the main composed are derived from the anterior columns of the spinal cord, and consist therefore of motor fibres. On separating the pyramids about an inch

below the pons, bundles of nerves are seen decussating across the anterior fissure (fig. 140). This is the explanation of *cross paralysis—i.e.* when one side of the brain is injured, the loss of motion is manifested on the opposite side of the body.* This decussation, which consists of three or four bundles on each side, involves only the inner fibres of the pyramid; the outer fibres ascend through the pons without crossing. The decussating fibres are the continuations upwards of the deep fibres of the

FIG. 141.

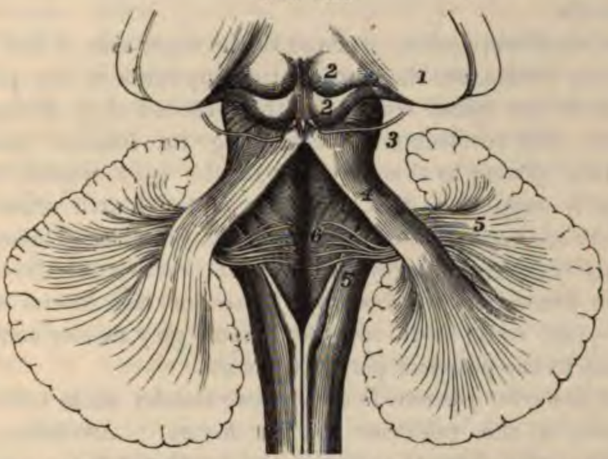


DIAGRAM OF THE FOURTH VENTRICLE AND RESTIFORM BODIES.

1. Thalamus opticus.
2. Nates and testes.
3. Origin of fourth nerve.
4. Processus a cerebello ad testes.
5. Restiform bodies diverging.
6. Origins of seventh or auditory nerve.

lateral columns of the spinal cord, which here come forwards to the surface, and push aside the anterior columns.

The *olivary bodies* are the two oval eminences situated on the outer side of the anterior pyramids, from which they are separated by a shallow depression. They do not ascend quite as high as the pons. They consist externally of white matter; and, when cut

* The phenomenon of cross paralysis of sensation is explained by the fact made out by Brown-Séquard, that the paths of sensory impressions cross each other in the grey matter of the cord.

into, their interior presents an undulating line of yellowish-brown colour, called from its zigzag shape the *corpus dentatum*. This, which is sometimes called the *olivary nucleus*, forms an interrupted circle, incomplete at its upper and inner side, so that it nearly isolates the white matter within. The small grey mass placed above the corpus dentatum, and similarly composed of grey matter, is called the *accessory olivary nucleus*. At the lower part of the olivary body, some white fibres may be observed arching round from the anterior median fissure, constituting the *arciform fibres* of Rolando.

The *restiform bodies*, situated to the outer side of and behind the olivary bodies, are the continuations upwards of the posterior columns of the spinal cord. As they ascend they diverge and pass into the cerebellum, constituting its inferior peduncles (fig. 141). Owing to this divergence, the grey matter of the medulla is exposed, so that the floor of the fourth ventricle (of which the restiform bodies assist in forming the lateral boundaries) is mainly composed of grey matter. The restiform bodies consist of white fibres derived from the posterior and lateral columns of the spinal cord; in its interior is some grey matter continuous with that in the posterior part of the cord.

The *posterior pyramids* are the two slender white columns on each side of the posterior median fissure. Ascending, they diverge and thus form the apex of the fourth ventricle. At their point of separation the posterior pyramids enlarge, and form the *processus clavatus*; after which they diminish in size, and run up with the restiform bodies, which, however, they soon leave and are continued upwards into the cerebrum along the floor of the fourth ventricle.

Emerging from the anterior median fissure may be noticed some superficial transverse white fibres which cross below the lower extremity of the olivary bodies, and sometimes also the anterior pyramids; these are known as the *arciform fibres* of Rolando (fig. 140). They are probably connected with white fibres which run horizontally, constituting an imperfect septum between the two halves of the medulla, and may be seen when a

longitudinal section is carefully made through its middle. The majority of these septal fibres enter the olivary bodies, and then emerging through the grey matter of the corpus dentatum, become continuous with the fibres of the restiform bodies and lateral tracts; others pass out from the posterior fissure and wind round the restiform bodies. These latter fibres are the *transverse striæ*, seen on the floor of the fourth ventricle, some of which form the roots of the auditory nerves.

PONS VAROLII, OR GREAT COMMISSURE OF THE CEREBELLUM. This convex eminence of transverse white fibres (p. 584) is situated at the base of the brain, immediately above the medulla oblongata. It rests upon the basilar groove of the occipital bone, and in its antero-posterior diameter measures rather more than an inch. The upper margin is convex, and arches over the crura cerebri; the lower is nearly straight, being separated from the medulla by a transverse groove. On each side the pons becomes narrower, in consequence of the transverse fibres being more closely aggregated; these enter the anterior part of the cerebellum, constituting its *middle crus*. Along the middle runs a shallow groove which lodges the basilar artery. If the pia mater be removed, we observe how the superficial fibres pass transversely, to connect the two hemispheres of the cerebellum. Throughout the mammalia the size of the pons bears a direct ratio to the degree of development of the lateral lobes of the cerebellum; therefore it is larger in man than in any other animal.*

When the superficial transverse fibres are dissected off, the longitudinal fibres of the anterior pyramids are seen passing up beneath them to enter the crura cerebri, like a river under a bridge, hence its name of pons. These pyramidal fibres are separated into yet smaller bundles by deeper transverse fibres, which, like the superficial transverse ones, are continued into the cerebellum.

Besides the transverse and longitudinal fibres just described,

* Birds, reptiles, and fishes have no pons, as there are no lateral lobes to the cerebellum.

the pons contains a considerable amount of grey matter, which is distributed between the transverse and longitudinal fibres.

The pons, like the medulla oblongata, has an imperfect median septum, composed of horizontal fibres, some of which at its anterior border surround the crura cerebri.

CEREBRUM.

The cerebrum in man is so much more developed than the other parts of the encephalon that it completely overlies them, and forms by far the largest portion. It is oval in form, and convex on its external aspect. It is divided in the middle line into two symmetrical parts, termed the right and left hemispheres, by the deep *longitudinal fissure*, which is occupied by the falx cerebri (p. 7).* The cerebrum is composed of numerous parts—viz., of certain internal ganglionic masses, the corpora striata, optic thalami, and corpora quadrigemina; of commissural white fibres, the fornix, corpus callosum, and the commissures of the third ventricle; of the pineal and pituitary bodies; and, lastly, of the two lateral hemispheres, which overlie and conceal the parts previously mentioned.

FIG. 142.

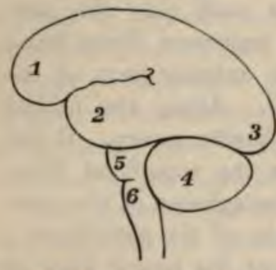


DIAGRAM OF THE GENERAL DIVISIONS OF THE BRAIN.

1, 2, 3. Anterior, middle, and posterior lobes of the cerebrum.
4. Cerebellum.
5. Pons Varolii.
6. Medulla oblongata.

The cerebrum rests upon the anterior and middle fossæ of the base of the skull, and the tentorium cerebelli. There are three surfaces to each hemisphere: an external or convex; an inner or median; and an inferior, interrupted by the fissure of Sylvius.

By widely separating the two hemispheres at the longitudinal fissure (the brain being in its natural position), we discover that they are connected in the middle by the transverse white com-

* Examples are occasionally met with, where the longitudinal fissure is not exactly in the middle line, the consequence of which want of symmetry is, that one hemisphere is larger than the other. Bichat ('Recherches physiologiques sur la Vie et la Mort,' Paris, 1829) was of opinion that this anomaly exercised a deleterious influence on the intellect. It is remarkable that the examination of his own brain after death went to prove the error of his theory.

missure, called the *corpus callosum*. In front of, and behind this white mass, the fissure extends to the base of the brain.

The surface of each hemisphere is mapped out by tortuous eminences termed *convolutions* (*gyri*), separated from each other by deep furrows, *sulci*. Many of the furrows are occupied by the large veins in their course to the sinuses; others are filled with subarachnoid fluid. The convolutions are folds of the brain, for the purpose of increasing the extent of the surface for the grey nerve-substance. They are not symmetrical on both sides, although they follow a somewhat similar arrangement. Their number, arrangement, and depth, vary somewhat in different individuals, and, to a certain extent, may be considered an index of the degree of intelligence.*

Since the grey matter forms a sort of bark round the white substance, it is often called the cortical substance. The depth of the sulci between the convolutions varies in different brains, from an inch to half an inch; hence it follows that two brains of equal size may be very unequal in point of extent of surface for the grey matter, and therefore in amount of intellectual capacity. Under the microscope the cortical layer is seen to consist of four layers, two grey alternating with two of white, the external layer being always white.†

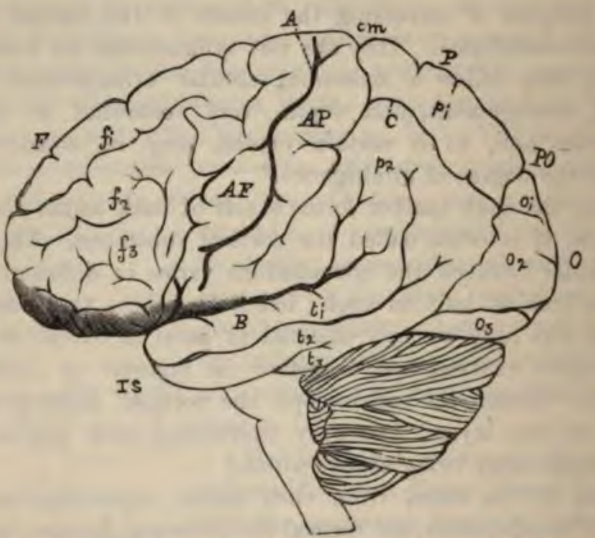
Some of the sulci, from their depth, regularity, and early period of development, are termed the *primary fissures*, and map out the surface of the cerebrum into its different lobes. Of these there are three: the *fissure of Sylvius*, the *fissure of Rolando* or *central fissure*, and the *parieto-occipital fissure* (fig. 143).

* Those who wish to investigate the cerebral convolutions in their simplest form in the lower classes of mammalia, and to trace them through their successive development and arrangement into groups as we ascend to the higher classes, should consult Leuret, 'Anatomie comparée du Système Nerveux considérée dans ses Rapports avec l'Intelligence,' Paris, 1839; also Foville, 'Traité de l'Anat. du Système Nerveux,' &c., Paris, 1844. The convolutions of the human brain have been described by Ecker, 'On the Convolutions of the Human Brain,' 1873; and by Turner, 'The Convolutions of the Human Brain, topographically considered,' Edin. 1866.

† Six layers may be demonstrated in some situations, chiefly near the corpus callosum and the occipital lobe. For an account of these laminæ see Lockhart Clarke, 'Proceed. Royal Society,' 1863.

The *fissure of Sylvius* is seen on the base of the cerebrum, and receives the lesser wing of the sphenoid bone. It curves outwards as a deep cleft, and divides into two rami; an ascending or vertical, about an inch in length, and a posterior or horizontal ramus, which passes backwards, and ends about the middle of the hemisphere.

Fig. 143.



VIEW OF THE CONVOLUTIONS AND FISSURES OF THE EXTERNAL SURFACE OF THE BRAIN (LEFT SIDE).

A. Fissure of Rolando.
B. Fissure of Sylvius.
C. Inter-parietal fissure.
P.O. Parieto-occipital fissure.
c.m. Calloso-marginal fissure.
F. Frontal lobe.
P. Parietal lobe.
O. Occipital lobe.
T.S. Temporo-sphenoidal lobe.
A.F. Ascending frontal convolution.
A.P. Ascending parietal convolution.
fi, *f2*, *f3*. Superior, middle, and inferior frontal convolutions, separated by the superior and inferior frontal sulci.
pi, *p2*. Superior and inferior parietal convolutions, separated by the inter-parietal fissure.
oi, *o2*, *o3*. Superior, middle, and inferior occipital convolutions, separated by the occipital fissures.
ti, *t2*, *t3*. Superior, middle, and inferior temporo-sphenoidal convolutions, separated by the superior and inferior temporo-sphenoidal fissures.

The *fissure of Rolando* or *central fissure* runs obliquely over the outer surface of the hemisphere. It commences close to the

longitudinal fissure about its middle, then runs downwards and forwards, and terminates a little above the fork of the Sylvian fissure.

The *parieto-occipital fissure* is seen on the median surface of the hemisphere towards its posterior part. It begins on its median surface about half an inch behind the corpus callosum, then ascends nearly vertically, and ends on the external aspect of the cerebrum about an inch from the longitudinal fissure.*

Other important fissures besides the primary just described are seen on the cerebral surface. They are chiefly found on the median aspect of the hemisphere, and are as follows (fig. 144):—

The *calloso-marginal fissure* runs nearly parallel with the anterior two-thirds of the corpus callosum, then, changing its direction, it ascends obliquely and terminates on the external aspect of the hemisphere, where it forms a deep notch immediately behind the fissure of Rolando.

The *calcarine fissure*, also seen on the median surface, begins close to the posterior border of the cerebrum, and then, running nearly horizontally forwards, terminates below the corpus callosum. Midway in its course it is joined at an acute angle by the parieto-occipital fissure.

The primary fissures form the boundaries of the various lobes of which each hemisphere is composed.

Thus the *frontal lobe* is that part of the cerebrum anterior to the fissure of Rolando on the external surface, and the calloso-marginal fissure on the median. The *parietal lobe* is placed between the fissure of Rolando and the external parieto-occipital fissure.

The *occipital lobe* consists of the posterior part of the hemisphere behind and below the parieto-occipital fissure. The *temporo-sphenoidal lobe* is bounded above by the horizontal ramus of the Sylvian fissure, and forms that part of the hemisphere which occupies the middle cerebral fossa.

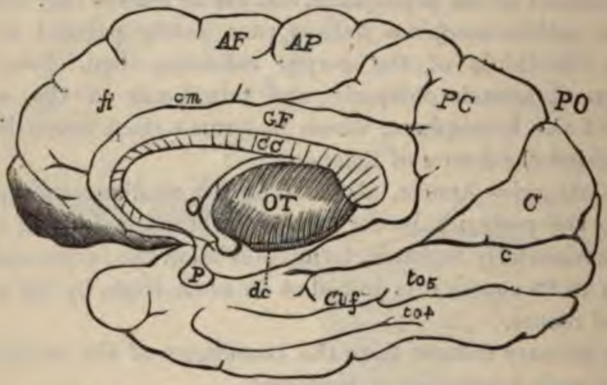
The *island of Reil* or the *central lobe* lies deep in the fissure

* The fissure of Rolando is first seen about the fifth month of fœtal life; the parieto-occipital fissure, between the fourth and fifth month.

of Sylvius. It consists of a number of hidden convolutions (*gyri operti*) connected with those adjoining it, and corresponds to the under surface of the corpus striatum. The frontal lobe is on its external surface divided by two frontal fissures into a superior, middle, and inferior frontal convolution (fig. 143).

The only fissure of the parietal lobe is the inter-parietal sulcus, which separates the upper from the lower parietal convolution, which latter is occasionally divided into the supra-marginal and angular gyrus; the one being above, the other behind the fissure of

Fig. 144.



CONVOLUTIONS AND FISSURES OF THE MEDIAN AND TENTORIAL SURFACES OF RIGHT HEMISPHERE.

C.C. Corpus callosum.
A.F. Ascending frontal convolution.
A.P. Ascending parietal convolution.
P.O. Parieto-occipital fissure.
P.C. Præcuneus or quadrate lobe.
C. Cuneus.
c. Calcarine fissure.
Clf. Collateral fissure.
G.F. Gyrus fornicatus.
cm. Calloso-marginal fissure.
fi. Superior frontal or marginal convolution.
O.T. Optic thalamus.
P. Pituitary body.
dc. Dentate convolution.
to4. Gyrus occipito-temporalis lateralis.
to5. Gyrus occipito-temporalis medialis.

Sylvius. Behind the fissure of Rolando is the ascending parietal convolution, which is usually continuous with the ascending frontal convolution, above and below the fissure.

The occipital lobe is composed of a superior, middle, and inferior occipital convolution, separated by ill-defined sulci, and connected with some parietal and temporo-sphenoidal convolutions

by the *annectant gyri.* The temporo-sphenoidal lobe is traversed by two parallel fissures, which divide it into a superior, middle, and inferior temporo-sphenoidal convolution. In front of the under aspect of this lobe, there is the *uncinate* or *hippocampal* convolution, which is continuous with the gyrus fornicatus. In this situation also we find two fissures, the *hippocampal* and the *collateral,* the former of which corresponds to the hippocampus major, the latter to the eminentia collateralis. The remaining convolutions are seen on the median surface of the hemisphere, and comprise the *gyrus fornicatus,* which courses round the corpus callosum; the *cuneus,* situated between the parieto-occipital and calcarine fissures; and the *præcuneus* or quadrate lobe placed in front of the parieto-occipital fissure.

NOMENCLATURE OF THE PARTS AT THE BASE OF THE BRAIN.

The several objects seen at the base of the brain in the middle line should now be examined, proceeding in order from the front (fig. 139, p. 580). In this description the cerebral nerves are omitted. These will be examined hereafter.

In the middle line, dividing the frontal lobes, is the longitudinal fissure. By gently separating these lobes, we expose the corpus callosum, or the great transverse commissure which connects the two hemispheres of the cerebrum. Continued backwards and outwards on each side from the corpus callosum to the fissure of Sylvius is a white band, the peduncle of the corpus callosum. Extending from the corpus callosum to the optic commissure is a thin grey layer, the lamina cinerea. Between the frontal and temporo-sphenoidal lobes is the fissure of Sylvius, which lodges the middle cerebral artery. The optic commissure, formed by the union of the two optic tracts, is seen in the middle line behind the lamina cinerea. At the root of the fissure of Sylvius is the locus perforatus* anticus. Immediately behind the optic commissure is a slight prominence of grey matter, the tuber cinereum; from this descends a conical tube of reddish colour, the infundibulum, to the apex of which is attached the pituitary body. Behind the tuber

* Called 'perforatus' from its being perforated by a number of blood-vessels, for the supply of the corpus striatum.

cinereum are two round white bodies, the corpora mammillaria. Posterior to these is the locus perforatus posticus, which is bounded behind by the pons, and laterally by the two diverging crura cerebri, two round cords of white substance, which emerge from the anterior border of the pons. Winding round the outer side of each crus is a soft white band, the optic tract.

Examine now in detail the various objects above enumerated, most of which are shown in fig. 139.

The *lamina cinerea* is a thin layer of grey substance, which connects the corpus callosum, and the optic commissure; it passes above this and becomes continuous with the tuber cinereum. If the lamina be torn, which is very easily done, an aperture is made into the third ventricle.

The *locus perforatus anticus*, placed to the inner side of the commencement of the fissure of Sylvius, is composed partly of grey substance; crossing it is seen a broad white band, the peduncle of the corpus callosum.

The *tuber cinereum* is a prominence of grey matter immediately behind the optic commissure, and from it a conical tube of reddish colour, the infundibulum, descends to the *pituitary body*. This body, which occupies the sella turcica, is of reddish-brown colour, and consists of two lobes; the anterior, the larger, is concave behind to receive the posterior lobe. It weighs from five to ten grains, and on section resembles in structure the thyroid gland, being composed of reticular tissue with numerous cavities filled with nucleated cells and granular matter.

The *corpora albicantia* or *mammillaria* are two round white bodies, which are formed by the curl of the anterior crura of the fornix.

The *locus perforatus posticus*,* is a depression of grey matter, the surface of which is penetrated by small vessels which supply the optic thalami.

ORIGIN OF THE CEREBRAL NERVES.

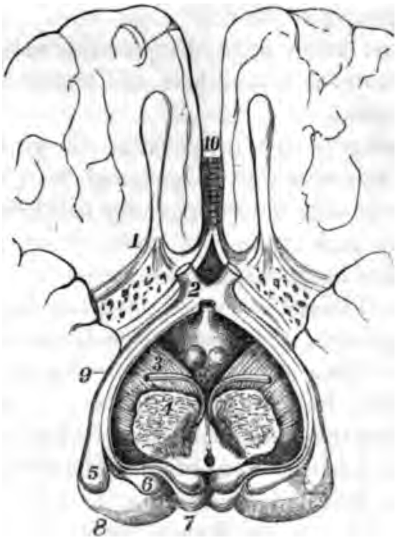
The cerebral nerves are given off in pairs, named the first, second, third, &c., according to the order in which they appear, beginning from the front.

* Pons Tarini.

There are nine pairs. Some are nerves of special sense—as the olfactory, the optic, the auditory; others are nerves of common sensation—as the larger root of the fifth, the glosso-pharyngeal, and the pneumogastric; others, again, are nerves of motion—as the third, the fourth, the smaller root of the fifth, the sixth, the facial division of the seventh, the spinal accessory, and the hypoglossal.

Fig. 145.

1. Olfactory n.
2. Optic n.
3. Crus cerebri.
4. Section of crus to show locus niger.
5. Corpus geniculatum externum.



6. Corpus geniculatum internum.
7. Corpora quadrigemina.
8. Thalamus opticus.
9. Tractus opticus.
10. Corpus callosum.

DIAGRAM OF THE ORIGINS OF THE OLFACTORY AND OPTIC NERVES.

First Pair or Olfactory Nerves. The olfactory nerve is triangular on section, the apex of the triangle being lodged in a furrow (*olfactory sulcus*) between the convolutions. It proceeds straight forwards under the frontal lobe, and terminates in the olfactory bulb, which lies on the cribriform plate of the ethmoid bone.

The olfactory lobe is oval, of a reddish-grey colour, and very soft consistence, owing to the large amount of grey matter contained in it. It gives off from its under surface about twenty branches,

which pass through the foramina of the cribriform plate.* For the description of these, see p. 233.

The nerve arises by three roots—an outer and an inner, composed of white matter, and a middle, composed of grey (p. 595).

The *outer* root passes forwards as a thin white line from the bottom of the fissure of Sylvius, and describes a curve with the concavity outwards. Its deeper origin has been traced to the optic thalamus and a nucleus in the anterior part of the temporo-sphenoidal lobe.

The *inner* root arises from the posterior extremity of the internal convolution of the frontal lobe, and thence may be traced to the gyrus fornicatus.

The *middle*, or grey root, arises from the grey matter of the sulcus, in which the nerve is lodged, and from the grey matter of the locus perforatus anticus; to see it, therefore, the nerve should be turned backwards. It contains white fibres in its interior, which have been traced to the corpus striatum.

SECOND PAIR OR OPTIC. The optic tracts arise from the corpora quadrigemina, the corpora geniculata, and the optic thalami (p. 595). They wind round the crura cerebri, with which they are connected by their anterior borders, and join in the middle line to form the optic commissure. This commissure rests upon the sphenoid bone in front of the sella turcica; and from it each optic nerve, invested by its fibrous sheath, passes through the optic foramen into the orbit and terminates in the retina.

At the commissure some of the nerve-fibres cross from one side to the other. This decussation affects only the middle fibres of

* Strictly speaking, the olfactory nerve and its ganglion are integral parts (the prosencephalic lobe) of the brain. What in human anatomy is called the origin of the nerve is, in point of fact, the crus of the olfactory lobe, and is in every way homologous to the crus cerebri or cerebelli. In proof of this, look at the enormous size and connections of the crus in animals which have very acute sense of smell. Throughout the vertebrate kingdom there is a strict ratio between the sense of smell and the development of the olfactory lobes. Again, in many animals, these lobes are actually larger than the cerebral, and contain in their interior a cavity which communicates with the lateral ventricles. According to Tiedemann, this cavity exists even in the human fœtus at an early period.

the nerve; the outer fibres pass from one optic tract to the optic nerve of the same side; the inner fibres pass from one optic tract round to the optic tract of the opposite side; while in front of the commissure are fibres which pass from one optic nerve to its fellow (p. 600).*

THIRD PAIR OR MOTORES OCULORUM.

The apparent origin of the third nerve is from the inner side of the crus cerebri, immediately in front of the pons. Some of its roots, however, pass through the locus niger and the tegmentum of the crus, to reach a grey nucleus beneath the iter a tertio ad quartum ventriculum and below the corpora quadrigemina (p. 595). It passes through the sphenoidal fissure and supplies all the muscles of the orbit, except the superior oblique and the rectus externus.

FOURTH PAIR OR TROCHLEAR NERVES.

The fourth nerve arises from the upper surface of the valve of Vieussens (p. 612). Here it divides into three sets of fibres: one, *ascending*, passes to the roof of the aqueduct of Sylvius; another, *decussating*, passes over to the opposite side to join the ascending fibres; and a third, or *descending*, which rises from the floor of the fourth ventricle close to the locus cæruleus. It runs obliquely outwards, winds round the crus cerebri, enters the orbit through the sphenoidal fissure, and supplies the superior oblique.

FIFTH PAIR OR TRIGEMINAL NERVE.

The fifth nerve consists of two roots, both of which arise apparently from the outer side of the pons Varolii (p. 584); but their real origin is deeper. The smaller and anterior of the two roots, consisting of motor fibres only, may be traced to the outer side of the fourth ventricle, and to a grey nucleus at the lower part of the medulla; the posterior and larger root consisting of purely sensory fibres, may be traced to a mass of nerve-cells in connection with the grey tubercle of Rolando, and also to the middle of the floor of the fourth ventricle. The nerve proceeds forwards over the apex of the petrous portion of the temporal bone; here is developed, upon

* This decussation was ingeniously supposed by Dr. Wollaston ('Philos. Trans. of the Royal Society,' 1824) to account for single vision, since the right halves and the left halves of the eyes would derive their nerve-fibres from the same optic nerve.

the sensitive root, the Gasserian ganglion. The root then divides into three branches—the *ophthalmic*, which passes through the sphenoidal fissure; the *superior maxillary*, which passes through the foramen rotundum; the *inferior maxillary*, which passes through the foramen ovale. They all confer common sensation upon the parts they supply, which comprises the entire face and sides of the head. The small motor root passes beneath the ganglion, with which it has no connection, and accompanies the inferior maxillary division, to be distributed to the muscles of mastication.

SIXTH PAIR OR ABDUCENTES. The sixth nerve emerges from the groove between the pons and the anterior pyramid (p. 584), with both of which it is connected. Its deep origin has been traced to a grey nucleus of nerve-cells in the floor of the fourth ventricle. It leaves the skull through the sphenoidal fissure, and supplies the rectus externus of the eye.

SEVENTH PAIR. The seventh comprises two nerves—the *portio dura*, or motor nerve of the face, and the *portio mollis*, or auditory nerve. The two nerves, of which the portio dura is the more internal and anterior, arise apparently from the lower border of the pons Varolii (p. 584). The deep origin of the *portio dura* is stated to pass through the medulla to the grey nucleus in the floor of the fourth ventricle near the origin of the sixth nerve. The deep origin of the *portio mollis* is from the internal auditory nucleus in the floor of the fourth ventricle. The nerve then passes outwards, and enters the meatus auditorius internus in company with the portio dura. For the further description of the *portio dura*, see p. 90. The auditory nerve divides at the bottom of the meatus auditorius internus into cochlear and vestibular branches, which are distributed to the internal ear.

EIGHTH PAIR. This comprises three nerves—the *glosso-pharyngeal*, the *pneumogastric*, and the *nervus accessorius* (p. 580). The glosso-pharyngeal nerve arises by several filaments from the restiform body of the medulla, through which they may be traced to a grey nucleus in the outer part of

the floor of the fourth ventricle, close to the nucleus for the vagus.

The pneumogastric nerve arises by numerous filaments which pass to a grey nucleus in the floor of the fourth ventricle, close to the middle line.

The nervus accessorius is composed of two parts—an upper or accessory portion, which arises from the medulla; and a lower or spinal portion, which arises from the spinal cord. The accessory fibres may be traced to the nucleus at the apex of the calamus scriptorius. The spinal portion arises by a series of slender filaments from the lateral tract of the spinal cord as low down as the fifth or sixth cervical vertebra. The spinal portion ascends behind the ligamentum denticulatum, through the foramen magnum, into the skull, and joins the accessory part. The nervus accessorius then passes through the foramen jugulare with the pneumogastric and glosso-pharyngeal nerves. The glosso-pharyngeal is distributed to the mucous membrane of the pharynx, and back of the tongue (p. 224). The pneumogastric is distributed to the pharynx, the larynx, the heart and lungs, the œsophagus, and stomach. The nervus accessorius supplies the sterno-mastoid, and the trapezius. For the further description of these nerves, see pp. 225, 226.

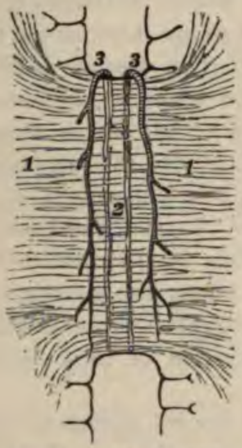
NINTH PAIR OR HYPOGLOSSAL. This nerve arises by several filaments from the medulla, along the groove between the anterior pyramid and the olive. Its fibres may be traced to a long grey nucleus, which forms an eminence in the floor of the fourth ventricle in front and to the inner side of the vagal nucleus. It leaves the skull through the anterior condyloid foramen, and is distributed to the muscles of the tongue and depressors of the os hyoides and larynx.

DISSECTION OF THE BRAIN. The brain should now be laid on its base. By gently separating the hemispheres, we expose at the bottom of the longitudinal fissure a white band of nerve-substance, which is the great transverse commissure of the cerebrum, and termed the *corpus callosum*.

Slice off the hemispheres down to the level of the corpus callosum. The cut surface presents a mass of white substance surrounded by a tortuous layer of grey matter, about one-eighth of an inch in thickness. This grey substance consists of four layers—two of grey alternating with two of white, the most external layer being white. In some places, chiefly at the base of the brain, six layers have been demonstrated.

WHITE AND GREY MATTER.

Fig. 146.



UPPER SURFACE OF CORPUS CALLOSUM.

1, 1. Lineæ transversæ.
2. Raphé.
3, 3. Anterior cerebral a.

Fig. 147.

DIAGRAM OF LAMINA CINEREA.

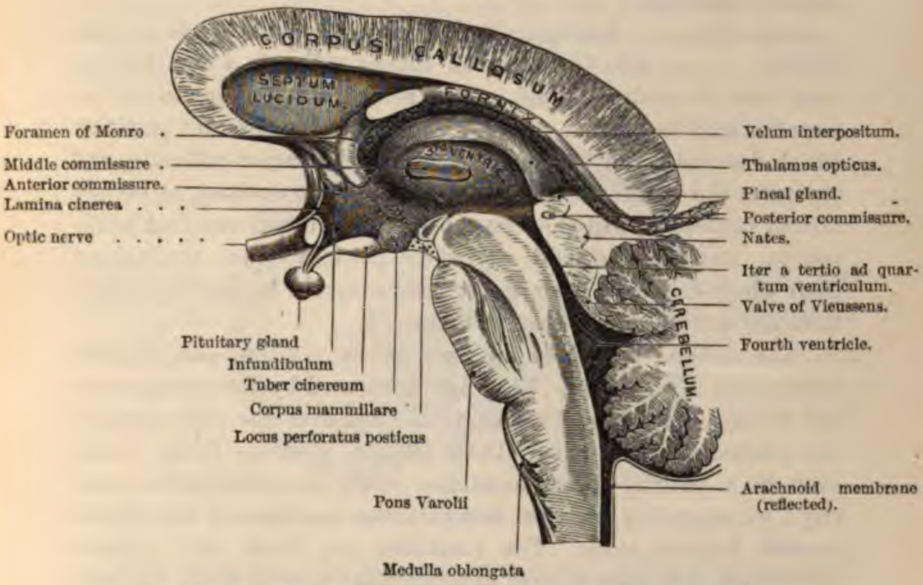
1, 1. Peduncles of corpus callosum.
2. Lamina cinerea.
3. Commissure of optic nerves.

CORPUS CALLOSUM.

This transverse portion of white substance is the chief connecting medium between the two hemispheres, and is called the *great transverse commissure* of the cerebrum. It is about four inches long, and is rather nearer to the front than to the back part of the brain. It is, moreover, thicker at the ends than in the middle. Its surface is slightly arched from before backwards. A shallow groove, called the *raphé*, runs along the middle of its upper surface (fig. 146); in a

fresh brain, two longitudinal white tracts, named the *nerves of Lancisi*, run parallel to it; and external to these again are two other longitudinal fibres, *striæ longitudinales laterales*. The surface of the corpus callosum is marked by transverse lines which indicate the course of its fibres; these are the *lineæ transversæ* of the old anatomists. The anterior cerebral arteries proceed along the surface of the corpus callosum to the back of the brain.

Fig. 148.



VERTICAL SECTION THROUGH THE CORPUS CALLOSUM, AND PARTS BELOW.

The anterior part of the corpus callosum turns downwards and backwards, forming a bend called its *genu*. The inferior part of this bend—*rostrum*—becomes gradually thinner and narrower, and terminates in two peduncles, which diverge from each other, and are lost, one in each fissure of Sylvius. Between these crura is placed the lamina cinerea (fig. 147). The posterior part of the corpus callosum terminates in a thick, round border which is free, and beneath it the pia mater enters the interior of

Slice off the hem
callosum. The cut s

White and Grey Matter. surrou
about
grey substance consist
with two of white, the
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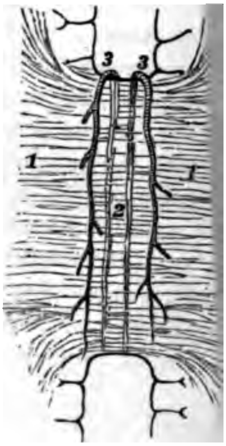
Fig. 146.



UPPER SURFACE OF CORPUS CALLOSUM.

1, 1. Lineæ transversæ.
2. Raphé.
3, 3. Anterior cerebral a.

Corpus Callosum. This trans[illegible]
the chief con[illegible]
hemispheres, and is called the [illegible]
cerebrum. It is about four inc[illegible]
the front than to the back pa[illegible]
thicker at the ends than in the
arched from before backwards.
raphé, runs along the middle of its

[illegible] cannot be obtained of the arch [illegible] its terminations in front and [illegible] its different parts, without [illegible] a fresh brain, as shown in [illegible]

[illegible] of the posterior part of the [illegible] it in front [illegible] septum—the [illegible]

[illegible]

[illegible] Two [illegible] one in each [illegible] should afterwards be laid open [illegible] Their general form should be [illegible] the several objects seen in them.

The *lateral ventricles* are two serous cavities [illegible] hemisphere of the brain. They are occasioned by the [illegible] and folding backward of the cerebral [illegible] the central nervous axis. They contain [illegible] in a healthy brain, sometimes [illegible] when greatly in excess it constitutes [illegible] hydrocephalus. The ventricles are [illegible] and upon a layer of [illegible] said to be peculiarly delicate connective tissue [illegible] spinal cord.

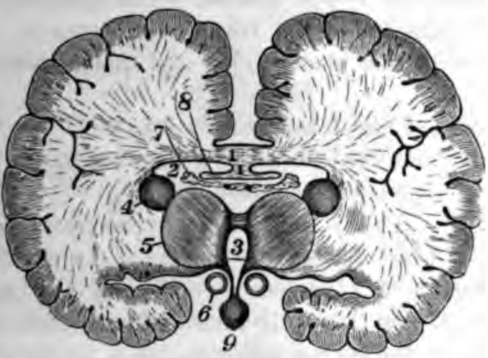
The ventricles are [illegible] in shape, [illegible] Each extends into the three [illegible] consists of a central part [illegible] anterior, middle, and posterior. [illegible]

[illegible]

the middle of the hemisphere, is separated from its fellow by the septum lucidum. Its roof is formed by the corpus callosum. On the floor, beginning from the front, are seen, the corpus striatum, the tænia semicircularis, the optic thalamus, the choroid plexus, and the fornix. The *anterior horn* extends into the frontal lobe, and as it passes forwards it diverges slightly from its fellow of the opposite side. Its roof is formed by the corpus callosum, and it curves round the anterior extremity of the corpus striatum. The *posterior horn* may be traced into the occipital lobe, where it passes at first backwards and outwards, and then onverges towards its fellow. In it are to be noticed an elevation

FIG. 149.

ns callosum.
ral ventricle.
l ventricle.
s striatum.
mus opticus.



6. Corpus mammillare.
7. Choroid plexus.
8. Fornix.
9. Pituitary gland.

TRANSVERSE VERTICAL SECTION THROUGH THE BRAIN.

e substance, the *hippocampus minor*, also a triangular flat external to it, called the *pes accessorius* or *eminentia lis.**

middle horn runs into the middle lobe, descends towards of the brain, making a curve, at first backwards and then downwards and forwards, and lastly inwards: the

terior horns are not always equally developed in both hemispheres, and y are absent in one or both.

nivora, ruminantia, solipeda, pachydermata, and rodentia, the lateral rolonged into the largely developed olfactory lobes. This is the case tus only at an early period.

the ventricles. A satisfactory view cannot be obtained of the arch formed by the corpus callosum, of its terminations in front and behind, and of the relative thickness of its different parts, without making a perpendicular section through a fresh brain, as shown in the preceding figure.*

Connected with the under surface of the posterior part of the corpus callosum is the fornix, which separates from it in front, the two structures being connected by a vertical septum—the *septum lucidum.*

LATERAL VENTRICLES. A longitudinal incision should be made on each side through the corpus callosum about half an inch from its median raphé. Care must be taken not to cut too near the middle line, in order to preserve the delicate partition which descends from the under surface of the corpus callosum, and separates the ventricles from each other. Two cavities, called the *lateral ventricles,* will thus be exposed, one in each cerebral hemisphere, and they should afterwards be laid open throughout their whole extent. Their general form should be first examined; then the several objects seen in them.

The *lateral ventricles* are two serous cavities, one in each hemisphere of the brain. They are occasioned by the enlargement and folding backward of the cerebral lobes over the other parts of the central nervous axis. They contain a serous fluid, which, even in a healthy brain, sometimes exists in considerable quantity; when greatly in excess it constitutes one form of the disease termed hydrocephalus. The ventricles are lined with ciliated epithelium, laid upon a layer of *neuroglia*; a term which has been applied to that peculiarly delicate connective tissue found throughout the brain and spinal cord.

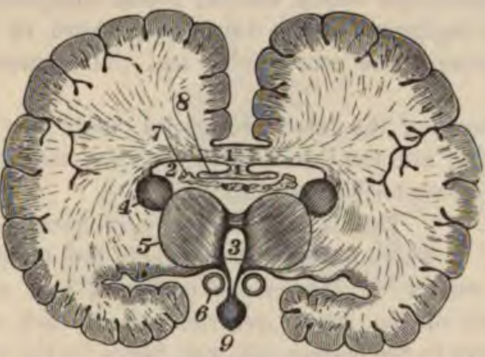
The ventricles are crescentic in shape, with their backs towards each other. Each extends into the three lobes of the cerebral hemisphere, and consists of a central part or *body,* and three horns or *cornua,* anterior, middle, and posterior. The body, situated in

* The corpus callosum is more or less developed in all mammalia, but is absent in birds, reptiles, and fish. It has been absent in the human subject without any particular mental deficiency. See cases recorded by Reil, 'Archiv für die Phys.' t. xi., and Wenzel, 'De plenitior. Struct. Cereb.' p. 302.

the middle of the hemisphere, is separated from its fellow by the septum lucidum. Its roof is formed by the corpus callosum. On the floor, beginning from the front, are seen, the corpus striatum, the tænia semicircularis, the optic thalamus, the choroid plexus, and the fornix. The *anterior horn* extends into the frontal lobe, and as it passes forwards it diverges slightly from its fellow of the opposite side. Its roof is formed by the corpus callosum, and it curves round the anterior extremity of the corpus striatum. The *posterior horn* may be traced into the occipital lobe, where it passes at first backwards and outwards, and then converges towards its fellow. In it are to be noticed an elevation

Fig. 149.

1. Corpus callosum.
2. Lateral ventricle.
3. Third ventricle.
4. Corpus striatum.
5. Thalamus opticus.



6. Corpus mammillare.
7. Choroid plexus.
8. Fornix.
9. Pituitary gland.

TRANSVERSE VERTICAL SECTION THROUGH THE BRAIN.

of white substance, the *hippocampus minor*, also a triangular flat surface external to it, called the *pes accessorius* or *eminentia collateralis*.*

The *middle horn* runs into the middle lobe, descends towards the base of the brain, making a curve, at first backwards and outwards, then downwards and forwards, and lastly inwards: the

* The posterior horns are not always equally developed in both hemispheres, and sometimes they are absent in one or both.

In the carnivora, ruminantia, solipeda, pachydermata, and rodentia, the lateral ventricles are prolonged into the largely developed olfactory lobes. This is the case in the hum,n fœtus only at an early period.

upwards, each to the optic thalamus of its own side. As they descend the anterior crura are joined by the peduncles of the pineal body and by the tænia semicircularis. Immediately behind and below the anterior crura is a passage through which the choroid plexuses of opposite sides are continuous with each other.

FORAMEN OF MONRO. This aperture is called the *foramen of Monro* (fig. 150). Strictly speaking, it is not a foramen, but only a communication between the two lateral and the third ventricles. The *posterior crura* are continued downwards and outwards from the body of the fornix as thin flat white bands intimately connected with the concave side of the hippocampus major as far down as the pes hippocampi. Each band is called the *tænia hippocampi* or the *corpus fimbriatum.**

The fornix should now be cut through, and its two portions reflected. On the under surface of the posterior portion are seen fibres, arranged transversely, belonging to the corpus callosum, constituting what is termed the *lyra.*

Between the fornix and the upper surface of the cerebellum is the *transverse fissure*, or *fissure of Bichat*, through which the pia mater enters the ventricles. The fissure extends from the middle downwards on each side to the base of the brain, as far as the end of the descending horn. It is of a horse-shoe shape, with the concavity directed forwards. The upper boundary of that part of the transverse fissure which extends into the middle horn is sometimes called the free margin of the hemisphere.

CORPUS STRIATUM. This body is so called because, when cut into, it presents alternate layers of white and grey matter.† It is a much larger mass of grey substance than it

* The fornix and septum lucidum are absent in fish; they are merely rudimentary in reptiles and birds; but all mammalia have them in greater or less perfection, according to the degree of development of the cerebral hemispheres.

† The white lines in the corpus striatum are produced by the fibres of the crus cerebri, which traverse this mass of grey matter before they expand to form the hemisphere. The grey matter itself is sometimes called the *anterior cerebral ganglion*. It is found in all mammalia, in birds, and, to a certain extent, in reptiles. On a transverse section it is triangular, with its base directed outwards. At this part it is divided by two clear lines into three zones. Outside is a grey layer called the *claustrum*.

appears to be; that which is seen projecting on the floor of the lateral ventricle being only a part of it. The *intra-ventricular* portion is pear-shaped, broad in front, and when traced backwards is found to taper gradually to a point on the outside of the optic thalamus (p. 605). The under part—*extra-ventricular* portion—of the corpus striatum lies embedded in the white substance of the hemisphere, and corresponds with the island of Reil.

TÆNIA SEMI-CIRCULARIS. This is a narrow semi-transparent band of longitudinal white fibres, which lies in the groove between the corpus striatum and the optic thalamus (fig. 151). In front, it is connected with the anterior crus of the fornix and descends with it to the corpus mammillare; behind, it is lost in the white substance of the middle horn of the lateral ventricle. A vein, one or more from the corpus striatum, passes underneath the tænia semi-circularis to join the vena Galeni.

HIPPOCAMPUS MAJOR. This is an elongated eminence of grey matter, covered with white, and is situated in the posterior part of the descending horn. It extends to the bottom of the horn, where it becomes somewhat expanded, and indented on the surface, so as to resemble the paw of an animal, whence its name, *pes hippocampi*. Attached along the front border of the hippocampus, is the posterior crus of the fornix.

HIPPOCAMPUS MINOR. This eminence, smaller than the preceding, is situated in the posterior horn. It consists of white matter externally, and corresponds to the calcarine fissure. Between the hippocampus major and minor, is a triangular smooth surface, called the *pes accessorius* or *eminentia collateralis*. This corresponds to the posterior ramus of the fissure of Sylvius.

VELUM INTERPOSITUM AND CHOROID PLEXUS. The *velum interpositum*, which supports the fornix, should now be examined. This is a layer of pia mater, which penetrates into the ventricles through the transverse fissure, beneath the posterior border of the corpus callosum, as shown in fig. 150. The shape of this vascular membrane is like that of the fornix, and its borders project beneath that body and form the red convoluted fringes called the *choroid plexuses*. These plexuses consist almost

entirely of tortuous ramifications of minute blood-vessels, and are covered with vascular villi. The villi themselves are covered with large spheroidal epithelial cells. In front, the plexuses communicate with each other through the foramen of Monro; behind, they descend into the middle horns of the lateral ventricles, and become continuous with the pia mater at the base of the brain. From the under surface of the velum two small vascular processes are prolonged into the third ventricle, forming the choroid plexuses of that cavity.

VENÆ GALENI.

Along the centre of the velum run two large veins, called *venæ Galeni*, which return the blood from the ventricles into the straight sinus.

The velum interpositum, with the choroid plexuses, must now be removed to expose the following structures shown in diagram (p. 610):—1. A full view of the optic thalamus. 2. Between the optic thalami is the *third ventricle*, a deep vertical fissure, situated in the middle line. 3. Behind the fissure is the pineal body, a vascular structure, about the size of a pea. From this body may be traced forwards two slender white cords, called its *peduncles*—one along the inner side of each optic thalamus. 4. Passing transversely across the third ventricle are *three commissures*—anterior, middle, and posterior, connecting the opposite sides of the brain. 5. Immediately behind the pineal body are four elevations, two on each side, called the *corpora quadrigemina*, or *nates* and *testes*. 6. These bodies are connected with the cerebellum by two bands, one on each side, termed the *processus a cerebello ad cerebrum*. 7. Between these cords extends a thin layer of grey substance, called the *valve of Vieussens*, beneath which lies the fourth ventricle.

THALAMUS OPTICUS.

This, called also the *posterior cerebral ganglion*, is the oval elevation seen on the floor of the lateral ventricle, immediately behind the corpus striatum and tænia semicircularis. The under surface rests upon its corresponding crus cerebri, and forms the roof of the middle horn of the lateral ventricle. Though white on the surface, its interior consists of alternate layers of white and grey matter. Beneath the posterior part of the thalamus are two small eminences, termed the

corpora geniculata, *internum* and *externum*. These consist of small accumulations of grey matter, beneath the white; one being situated to the outer, the other to the inner side of the optic tract, fig. 145. A narrow band of white substance connects the external one with the nates, and a similar band connects the internal one with the testes.*

THIRD VENTRICLE. This is the narrow fissure between the optic thalami, and reaches down to the base of the brain. Its roof is formed by the velum interpositum and fornix; the floor, which increases in depth in front, is formed by certain parts at the base of the brain, found within the interpeduncular space—viz., the locus perforatus posticus, corpora mammillaria, tuber cinereum, infundibulum, and lamina cinerea, all of which are best seen in a vertical section, as shown p. 601. In front, it is bounded by the anterior crura of the fornix, and the anterior commissure; laterally, by the optic thalami and the peduncles of the pineal body; behind, it communicates with the fourth ventricle through the *iter a tertio ad quartum ventriculum*, which is a long canal beneath the corpora quadrigemina.

COMMISSURES. Passing across the third ventricle are seen three commissures, the anterior, middle, and posterior. The *middle commissure* may be seen by gently separating the optic thalami, and is about half an inch in breadth.

MIDDLE. This is composed entirely of grey substance, and in most brains, owing to its softness, is generally torn before it can be examined.† The *anterior commissure* is a round white

ANTERIOR. cord, which lies immediately in front of the anterior crura of the fornix, and connects the corpora striata. This commissure may be traced on each side, through the corpora striata, extending backwards far into the

* These bands are faintly marked in man, but are more apparent in the lower animals.

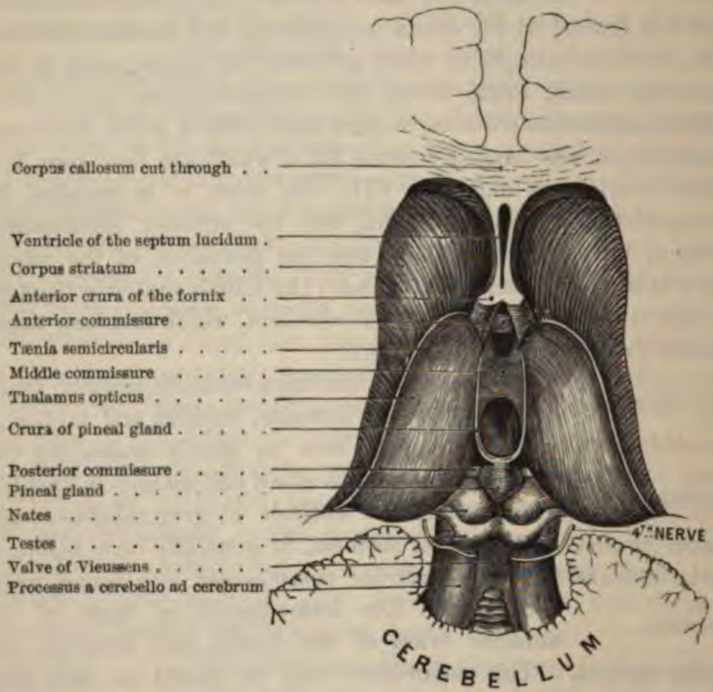
† The soft commissure does not appear to be a very essential constituent part of the brain. It is not found before the ninth month of fœtal life; and in some instances, according to our observations, is never developed. Wenzel states that it is absent in about one out of seven subjects ('De plenitiori Struct. Cerebri Hom. et Brut.' Tübingen, 1812).

temporo-sphenoidal lobes. Situated immediately in front of and rather below the pineal body is another thin round white cord called the *posterior commissure*. Its fibres pass into the substance of the hemisphere and connect the optic thalami.

POSTERIOR.

The third ventricle communicates with the lateral ventricles

FIG. 151.



through the foramen of Monro, and with the fourth ventricle through the iter a tertio ad quartum ventriculum.

PINEAL BODY, OR GLAND.

This very vascular oval body is situated immediately in front of the corpora quadrigemina (fig. 151). It is firmly connected with the under surface of the velum, and is apt to be separated from its normal position when that membrane is

reflected. It is about the size of a cherry-stone, and has two white peduncles or *crura*, which extend forwards, one on the inner side of each optic thalamus, and terminate by joining the anterior crura of the fornix. These crura are connected together behind, and with the front of the posterior commissure. In its interior it contains, besides some viscid fluid, more or less gritty matter, consisting of phosphate and carbonate of lime.

Although the pineal body is found in all mammalia, birds, and reptiles, in the same typical position, its functions are entirely unknown.

CORPORA QUADRIGEMINA. These are four eminences, situated, two on each side, behind the pineal body, and are separated from each other by a crucial depression. Laterally, they are connected with the optic thalami and crura cerebri, and are placed above the iter a tertio ad quartum ventriculum. Though white on the surface, they contain grey matter in the interior for the purpose of giving origin to the optic tract. A more appropriate term for them would be the 'optic lobes,' instead of 'nates and testes,' handed down from the old anatomists. The nates, the more anterior, are rather darker and larger than the testes: and from both proceed outwards two flat white cords, the *anterior and posterior brachia*. The anterior proceeds to the optic tract, optic thalamus and corpus geniculatum externum, the posterior to the crus cerebri and corpus geniculatum internum.*

PROCESSUS A CEREBELLO AD CEREBRUM. By gently drawing back the overlapping cerebellum, two broad white cords are seen, which pass backwards, diverging from each other, from the corpora quadrigemina to the cerebellum (fig. 151). These are the *processus a cerebello ad cerebrum*, or *superior peduncles of the cerebellum*. They connect the cerebrum and cerebellum,

* Eminences homologous to the corpora quadrigemina are found in all vertebrate animals; they are the meso-cephalic lobes; they always give origin to the optic nerves, and their size bears a direct relation to the power of sight. They are relatively smaller in man than in any other animal. In birds there are only two eminences, and these are very large, especially in those far-seeing birds which fly high, as the eagle, falcon, vulture, &c., who require acute sight to discern their prey at a distance.

and rest upon the crura cerebri. The space between them is occupied by a thin layer of grey matter, which covers the fourth ventricle. This layer is called the *valve of Vieussens*, is narrow in front, and broad posteriorly, where it is connected with the central portion of the cerebellum.

ITER A TERTIO AD QUARTUM VENTRICULUM OR AQUEDUCT OF SYLVIUS.

The third ventricle is connected with the fourth by a canal large enough to admit a probe, which runs backwards beneath the posterior commissure and the corpora quadrigemina (p. 601). This passage, together with the third and fourth ventricles, are persistent parts of the central canal which in early fœtal life extended down the middle of the cerebrospinal axis. It subsequently becomes much encroached upon by the large increase of grey substance, and in its floor are seen the nuclei common to the third and fourth nerves of each side.

FOURTH VENTRICLE.

This space is situated between the cerebellum and the posterior part of the medulla oblongata and pons Varolii. It is only a dilated portion of the primordial canal alluded to in the last paragraph. To obtain a perfect view of its boundaries, a vertical section should be made, as in diagram (p. 601). It appears triangular, and its boundaries are as follows:—The front or base is formed by the medulla oblongata and pons Varolii; the upper wall by the valve of Vieussens and the aqueduct of Sylvius; the posterior wall by the inferior vermiform process of the cerebellum; below, by the continuation of the arachnoid membrane on to the spinal cord; and, laterally, by the processus a cerebello ad cerebrum, posterior pyramids, and restiform bodies. The pia mater is prolonged for a short distance into the lower part of the cavity, and forms the *choroid plexus of the fourth ventricle*.*

The anterior wall of the fourth ventricle is lozenge-shaped, and on it are the following objects, which should be separately

* Tiedemann proposed to call the fourth ventricle the first: because in the fœtus, it is formed sooner than any of the others; because it exists in all vertebrated animals, whereas the lateral ventricles are absent in all osseous fishes; and because the ventricle of the septum lucidum is absent in all fishes, in reptiles, and in birds.

examined (p. 585):—1. A median groove, the remains of the primitive axis canal; running parallel to it on each side is a round elevation, the *fasciculus teres.* 2. From the lower part of the furrow two white cords (the *restiform bodies* or *inferior crura cerebelli*) pass off from the medulla oblongata, diverging like the branches of the letter V, and enter the lateral hemispheres of the cerebellum. The divergence of these cords, with the median furrow, was called by the old anatomists the *calamus scriptorius.* 3. The floor of the fourth ventricle is covered by grey matter, which is the grey substance of the medulla exposed by the divergence of the restiform bodies; one slight accumulation, external to the fasciculus teres, has received the name of *locus cœruleus.* 4. On the floor are seen a number of transverse white lines—*striæ medullares*—emerging from the median groove, some of which form part of the origin of the auditory nerves.

CEREBELLUM. This portion of the brain is situated in the occipital fossa, beneath the posterior lobes of the cerebrum, from which it is separated by the tentorium. Its form is ellipsoidal, with the long axis transverse. When the arachnoid membrane and the pia mater are removed, it is noticed that its surface is darker, and not arranged in convolutions like those of the cerebrum. It consists of a multitude of thin plates, *folia,* disposed in a series of concentric curves, with the concavity forwards. By a little dissection, it is easy to separate some of the laminæ from each other, and to see that the intervening fissures increase in depth from the centre towards the circumference.

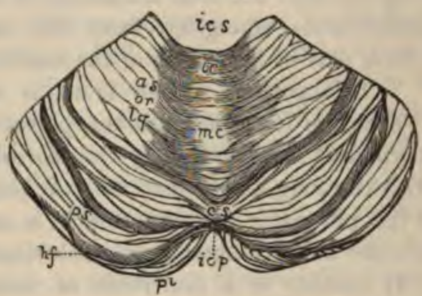
The cerebellum consists of two *lateral hemispheres* united by an intermediate portion, the *vermiform process,* the upper aspect of which takes the name of the superior vermiform process, the inferior that of the inferior vermiform process. Comparative anatomy proves that this is the fundamental part of the cerebellum, the lateral masses not being developed in the vertebrate series until after the birds. In man they form by far the largest part of the cerebellum.

The upper surface is divided from the lower by a deep fissure,

named the *great horizontal,* which extends along the free border of each hemisphere.

UPPER SURFACE. The upper surface of the cerebellum slopes on each side, having a ridge along the middle line, called the superior vermiform process. This process presents three eminences, an anterior, middle, and posterior, which are named respectively, the *lobulus centralis,* the *monticulus cerebelli,* and the *commissura simplex.* The hemispheres are separated posteriorly by a deep notch, the *incisura cerebelli posterior,* which receives the falx cerebelli. On this surface of the cerebellum are two lobes, one of which, the *quadrate,* is situated on its

FIG. 152.



SUPERIOR SURFACE OF THE CEREBELLUM.

ics. Incisura cerebelli anterior.
icp. Incisura cerebelli posterior.
as or *lq.* The anterior superior or quadrate lobe.
ps. The posterior superior lobe.
pi. The posterior inferior lobe.
hf. The great horizontal fissure.
lc. The lobulus centralis.
mc. Monticulus cerebelli.
cs. Commissura simplex.

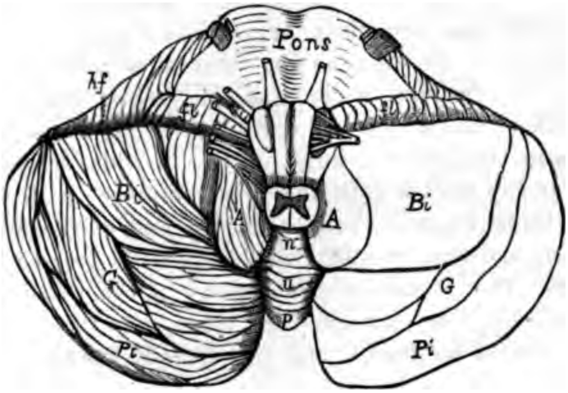
external and anterior aspect, the other, the *posterior,* is placed along its posterior border.

UNDER SURFACE. On the under surface of the cerebellum, its division into two hemispheres is clearly perceptible. The deep furrow between them is called the *vallecula.* The front part of it is occupied by the medulla oblongata. To examine the surface of the valley the medulla must be raised, and the hemispheres separated from each other. Along the middle line of the vallecula is the *inferior vermiform process,*

which is the under surface of the fundamental part of the cerebellum. Traced forwards, this process terminates in the *nodule*; traced backwards, it ends in a small conical projection, called the *pyramid*; between these is a tongue-like body, called the *uvula*.

Each hemisphere presents on its under surface certain secondary lobes, to which different names have been applied (fig. 153). That portion which immediately overlies the side of the vallecula is called the *tonsil* (*amygdala*); this is connected with the uvula by an indented layer of grey matter, called the *furrowed*

FIG. 153.



INFERIOR SURFACE OF THE CEREBELLUM.

A. The amygdala.
Bi. The biventral lobe.
G. The slender lobe.
Pi. The posterior inferior lobe.
h f. The great horizontal fissure.
f l. The flocculus.
n. The nodule, *u.* The uvula, *p.* The pyramid — situated in the vallecula.

band. At the anterior part of each hemisphere, near the middle line, is a little lobe named the *flocculus* or *subpeduncular lobe.*

From either side of the uvula may be traced a thin valve-like fold of white substance, which proceeds in a semicircular direction to the flocculi. These folds form the *posterior medullary velum.** To see this satisfactorily, the tonsils must be carefully separated from each other.

* These are sometimes called the *valves of Tarini.*

In addition to the amygdalæ and flocculi, already mentioned, other lobes have been described on the under surface of the cerebellum. Thus, there is the *digastric* lobe, situated external to the amygdala; and behind this are successively the *slender* and the *posterior inferior* lobes.

PEDUNCLES OF THE CEREBELLUM. The cerebellum is connected with the cerebro-spinal axis by three *peduncles* or *crura*—a superior, middle, and inferior. With the medulla oblongata it is connected by means of the restiform tracts; these are called the *processus a cerebello ad medullam*, or its *inferior peduncles*; with the cerebrum it is connected by means of the *processus e cerebello ad cerebrum*; these are called its *superior peduncles*. The lateral portions of the pons constitute its *middle peduncles*.

INTERNAL STRUCTURE. To examine the internal structure of the cerebellum, a longitudinal section must be made through the thickest part of one of its hemispheres. There is then seen in the centre a large nucleus of white substance, from which branches radiate into the grey substance in all directions. Each of these branches corresponds to one of the folia of the cerebellum, and from it other smaller branches proceed and again subdivide. This racemose arrangement of the white matter in the substance of the grey has been likened to the branches of a tree deprived of its leaves, and is generally known as the *arbor vitæ*.

CORPUS DENTATUM. In the centre of the white substance of each hemisphere is a nucleus of grey matter, the *corpus dentatum*, consisting of a zigzag line of yellowish-grey colour, incomplete at its upper and inner part, and enclosing within it some white substance. From its centre white fibres may be traced to the superior cerebellar peduncles and the valve of Vieussens. It is displayed either by a vertical or by a horizontal section.

FUNCTIONS. Respecting the function of the cerebellum, the deductions derived from comparative anatomy and physiological experiments render it probable that it is the co-ordinator of muscular movements—*e.g.*, in walking, flying, and swimming.

DISSECTION OF THE SPINAL CORD.

To examine, in situ, the spinal cord covered with its membranes, the arches of the vertebræ must be sawn through, and removed. It is then noticed that the cord does not occupy the whole cavity of the spinal canal. The dura mater does not adhere to the vertebræ, and does not form their internal periosteum, as in the skull. Between the bones and this membrane, a space intervenes, which is filled with a soft reddish-looking fat, with watery cellular tissue, and the ramifications of a plexus of veins.

FIG. 154.

1. Anterior external veins.
2. Posterior external veins.

3. Posterior longitudinal spinal veins.
4. Anterior longitudinal spinal veins.

DIAGRAM OF THE SPINAL VEINS. (Vertical section.)

SPINAL SYSTEM OF VEINS. The spine is remarkable for the number of large and tortuous veins which ramify about it, inside and outside the vertebral canal (fig. 154).* There are—1. The *posterior external veins* which form a tortuous plexus outside the arches and spinous processes of the vertebræ; they send off branches, which pass through the ligamenta subflava, and end in the plexus inside the vertebral canal. 2. The *veins of the bodies of the vertebræ* emerge from the backs of the bodies, and empty themselves into — 3. the *anterior longitudinal spinal veins*; these, two in number, one on each side, are the

* Vide Breschet, 'Essai sur les Veines du Rachis,' 4to.; 'Traité Anatomique sur le Système Veineux, fol. avec planches,' 1829; also Cloquet, 'Traité d'Anatomie descriptive.'

large tortuous veins which extend down the spinal canal, behind the bodies of the vertebræ. 4. The *posterior longitudinal spinal veins*, like the anterior, run along the whole length of the spinal canal. They form a tortuous venous plexus, situated inside the vertebral arches, and communicate with the anterior longitudinal veins by cross branches at frequent intervals. 5. The proper *veins of the spinal cord* lie within the dura mater. They form a fine plexiform arrangement of veins over both surfaces of the cord, and can with difficulty be injected from the other spinal veins. This complicated system of veins discharges itself through the intervertebral foramina in the several

Fig. 155.

1. Anterior external veins.
2. Posterior external veins.
3. Posterior longitudinal spinal veins.

4. Anterior longitudinal spinal veins.
5. Internal veins of the body of the vertebra.
6. Lateral veins.

DIAGRAM OF THE SPINAL VEINS. (Transverse section.)

regions of the spine, as follows:—In the cervical, into the vertebral veins; in the dorsal, into the intercostal veins; in the lumbar, into the lumbar veins. None are provided with valves: hence they are liable to become congested in diseases of the spine.

The membranes of the spinal cord, though continuous with those of the brain, differ from them in certain respects, and require separate notice.

DURA MATER. The dura mater of the cord is a tough fibrous membrane like that of the brain, but does not adhere to the bones, being separated from them by fat, loose areolar tissue, and the plexus of veins described above. Moreover, such adhesion would impede the free movement of the vertebræ

upon each other. It is attached firmly above to the margin of the foramen magnum, and may be traced downwards as a sheath as far as the second bone of the sacrum, from which it is prolonged as a cord to the coccyx, where it becomes continuous with the periosteum. It forms a complete canal or bag, which surrounds loosely the spinal cord, and sends off a prolongation over the trunk of each spinal nerve. These prolongations accompany the nerves only as far as the intervertebral foramina, and are then blended with the periosteum.

Cut through the nerves which proceed from the spinal cord on each side, and remove the cord with the dura mater entire. Then slit up the dura mater along the middle line, to examine the arachnoid membrane.

ARACHNOID MEMBRANE. The arachnoid membrane of the cord is a continuation from that of the brain, and, like it, consists of a *visceral* layer, which surrounds the cord, and a *parietal*, which lines the inner surface of the dura mater. The visceral layer is not in immediate contact with the pia mater beneath it, but is separated from it by a transparent watery fluid contained in the meshes of the subarachnoid tissue (p. 579.)

CEREBRO-SPINAL FLUID. This cerebro-spinal fluid cannot be demonstrated unless the cord be examined very soon after death, and before the removal of the brain.* The nerves proceed-

* The existence and situation of the cerebro-spinal fluid were first discovered by Haller, 'Element. Phys.' vol. iv. p. 87, and subsequently more minutely investigated by Magendie, 'Recherches Phys. et Cliniques sur le Liquide Cephalo-rachidien,' in 4to. avec atlas: Paris, 1842. This physiologist has shown that if, during life, the arches of the vertebræ are removed in a horse, dog, or other animal, and the dura mater of the cord punctured, there issue jets of a fluid which had previously made the sheath tense. The fluid communicates, through the fourth ventricle, with that in the general ventricular cavity. The collective amount of the fluid varies from 1 to 2 oz. or more. It can be made to flow from the brain into the cord, or *vice versâ*. This is proved by experiments on animals, and by that pathological condition of the spine in children termed 'spina bifida.' In the latter instance, coughing and crying make the tumour swell; showing that fluid is forced into it from the ventricles. Again, if pressure be made on the tumour with one hand, and the fontanelles of the child examined with the other, in proportion as the spinal swelling decreases so is the brain felt to swell up, accompanied by symptoms resulting from pressure on the

ing from the cord are loosely surrounded by a sheath of the arachnoid; but this only accompanies them as far as the dura mater, and is then reflected upon that membrane.

PIA MATER. The pia mater of the cord is the protecting membrane, which immediately invests it. It is very different in structure from that of the brain, since it does not constitute a membrane in which the arteries break up, but serves rather to support and strengthen the cord: consequently, it is much less vascular, more fibrous in its structure, and more adherent to the substance of the cord. It sends down thin folds into the anterior and posterior median fissures of the cord, and is prolonged upon the spinal nerves, forming their investing membrane or 'neurilemma.'

Over the anterior median fissure may be traced a well-marked fibrous band, formed by the pia mater, which has been named the *linea splendens*.

Below the level of the second lumbar vertebra, the pia mater is continued as a slender filament, called the *filum terminale*, or *central ligament*, which runs down in the middle of the bundle of nerves into which the spinal cord breaks up. About the level of the third sacral vertebra it becomes continuous with the dura mater of the cord, and is then prolonged as far as the base of the coccyx. The spine of the third sacral vertebra marks the level to which the cerebro-spinal fluid descends in the vertebral canal.

LIGAMENTUM DENTICULATUM. From each side of the cord along its whole length there runs a fibrous band, *ligamentum denticulatum*, which gives off a series of processes to steady and support the cord. They are triangular, their bases being attached to the cord, and their points to the inside of the dura mater (fig. 156). There are from eighteen to twenty-two of them on each side, and they lie between the anterior and posterior roots of the spinal nerves. The first process passes between the vertebral artery and the hypoglossal nerve; the last is found at the termination of the cord. It is composed of fibrous tissue, and is

nervous axis generally. See some remarks very much to the point, by Sir George Burrows, 'On Diseases of the Cerebral Circulation,' p. 50, 1846.

covered with nucleated cells continuous with the arachnoid membrane.*

Fig. 156.

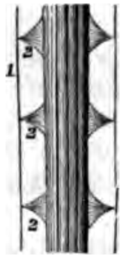


DIAGRAM OF THE LIGAMENTUM DENTICULATUM.

1. Dura mater.
2, 2, 2. Ligamentum denticulatum.

SPINAL CORD. The spinal cord is that part of the cerebro-spinal axis contained in the vertebral canal. It is the continuation of the medulla oblongata, and extends from the foramen magnum down to the upper border of the second lumbar vertebra, where it terminates in a conical point, *conus medullaris*, after having given off the large bundle of nerves termed *cauda*

CAUDA EQUINA. *equina*, for the supply of the lower limbs. From the conus medullaris there is continued downwards a slender cord, the *filum terminale*, which passes within the sheath to the coccyx.† The length of the cord is from fifteen to eighteen inches, and its general form is cylindrical, slightly flattened in front and behind. It is not of uniform dimensions throughout. It presents a considerable enlargement in the lower part of the cervical region; another in the lower part of the dorsal, from which proceed the large nerves to the upper and lower limbs, respectively. The upper or cervical enlargement, which is the larger, extends from the third cervical to the first dorsal vertebra; the lower, or lumbar, is situated opposite to the last dorsal vertebra.‡

FISSURES. The cord is divided into two symmetrical halves by a median longitudinal fissure in front and behind (fig. 157). The *anterior fissure* is the more distinct, and

* *Vide* Axel, Key, and Retzius; Max Schultze's 'Archives,' 1873.

† The explanation of this is, that, at an early period of fœtal life, the length of the cord corresponds with that of the vertebral canal; but after the third month, the lumbar and sacral vertebræ grow away from the cord, in accordance with the more active development of the lower limbs. See Tiedemann, 'Anatomie und Bildungsgeschichte des Gehirns im Fœtus des Menschen,' &c.; Nüremberg, 1816.

‡ In very early fœtal life these enlargements do not exist, and only make their appearance with the development of the extremities.

penetrates about one-third of the substance of the cord. It con-tains a fold of pia mater, with many blood-vessels for the suppl of its interior. At the bottom of this fissure is a transvers layer of white substance, named the *anterior white commissur* connecting the two anterior halves of the cord. The *posterio fissure* is so much less apparent than the anterior, that som anatomists deny its existence; but by careful preparation it ca be demonstrated, although it does not contain a fold of pia mate Indeed, it can be traced to a greater depth than the anterio and reaches down as far as the *posterior grey commissure* o the cord.

Besides the anterior and posterior fissures, along each half o the cord are two superficial grooves, from which the anterior an posterior roots of the spinal nerves respectively emerge. Thes

FIG. 157.

1. Dura mater.
2. Arachnoid membrane.
3. Ganglion on posterior root of spinal nerve.

4. Anterior root
spinal nerve.
5, 5. Seat of sub-arac
noid fluid.
6. Posterior branch
spinal nerve.
7. Anterior branch
spinal nerve.

DIAGRAM OF A TRANSVERSE SECTION THROUGH THE SPINAL CORD AND ITS MEMBRANES.

are the *anterior* and *posterior lateral fissures* (fig. 157) The posterior leads down to the posterior horn of the gre matter in the interior of the cord; the anterior is simpl the groove from which the anterior roots emerge. By thes lateral fissures each half of the cord is divided int three longitudinal columns—an *anterior*, a *pos-terior*, and a *lateral*. On each side of the posterior media fissure is a slender column, called the *posterior median column* which is separated from the posterior column by a shallow furrow.

COLUMNS.

INTERNAL STRUCTURE.

A transverse section through the cord (fig. 157 shows that, externally, it is composed of whit nerve-substance, and that its interior contains grey matter arranged in the form of two crescents, with their backs to each

other. Each crescent is placed in the corresponding half of the cord, and is connected with its fellow across the centre by a portion called the *posterior* or *grey commissure.** The *posterior horns* are long and narrow, and extend to the posterior lateral fissure, where they are connected with the posterior roots of the spinal nerves. The *anterior horns* are short and thick, and come forwards towards the attachment of the anterior roots of the nerves, but do not reach the surface. Separating the grey commissure from the anterior median fissure is the *anterior* or *white commissure.*

On making transverse sections through different regions of the spinal cord the grey substance is seen to vary in shape: in the cervical region the anterior cornua are thick and short, the posterior are long and slender; in the dorsal, the anterior and posterior cornua are both thin; in the lumbar, the anterior and posterior cornua are large and broad; in the lower part of the cord the grey matter is arranged in a central mass. Running along the centre of the cord in its whole length is a minute canal, just visible to the naked eye. It is lined with cylindrical ciliated epithelium, and opens superiorly into the fourth ventricle. The central canal is interesting, as it is the remains of the cavity formed by the spinal cord at the earliest period of its development.†

CENTRAL CANAL.

SPINAL NERVES.

Thirty-one pairs of nerves arise from the spinal cord, namely, eight in the cervical region, twelve in the dorsal, five in the lumbar, five in the sacral, and one in the coccygeal. Each nerve is formed by the junction of two series of roots, one from the front, the other from the back of the cord.

TWO ROOTS, SENSITIVE AND MOTOR.

Sir Charles Bell first discovered the fact, that the anterior roots consist exclusively of motor filaments, and the posterior exclusively of sensory.

* The different appearances of the arrangement of the grey matter in the cord have been accurately described and figured by Rolando, 'Richerche Anatomiche sulla Struttura del Midollo Spinale, con Figure, art. tratto dal Dizionario Periodico di Mediana;' Torino, 1824, 8vo. p. 55.

† The central canal is well seen in fishes, birds, and reptiles.

All converge in the corresponding invertebral foramen to form single nerve, composed of motor and sensory filaments.

The filaments of the *posterior* or sensory roots are thicker and more numerous than the anterior. They proceed from the posterior lateral fissure, and previous to their union with the anterior roots are collected together and pass through a ganglion. The ganglion is of an oval form, and lies in the intervertebral foramen. The fibres composing these roots enter the cord, and may be traced to the posterior cornu, through which they pass in various directions. The *anterior* roots arise from the fissure between the anterior and lateral columns of the cord. The fibres of the anterior root may be traced through the antero-lateral fissure into the anterior cornu.*

The compound nerve formed by the junction of the two roots (after the formation of the ganglion of the posterior) divides, outside the intervertebral foramen, into an anterior and a posterior branch. See diagram, p. 622.

VARIATION IN THE LENGTH OF THE ROOTS.

The direction and length of the roots of the nerves vary in the different regions of the spine, owing to the respective parts of the cord from which they arise not being opposite to the foramina through which the nerves leave the spinal canal. In the upper part of the cervical region, the origins of the nerves and their point of exit are nearly on the same level; therefore the roots proceed transversely, and are very short. Lower down, however, the obliquity and length of the roots gradually increase, so that the roots of the lower dorsal nerves are at least a vertebra higher than the foramina through which they emerge. Again, since the cord itself terminates at the upper border of the second lumbar vertebra,

* The researches of Blandin, 'Anat. descript.,' t. ii., p. 648, 1838, have led him to establish the following relation between the respective size of the anterior and posterior roots of the nerves in the several regions of the spine:—

The posterior roots are to the anterior in the			cervical region	::	2	:	1
„	„	„	dorsal „	::	1	:	1
„	„	„	lumbar and sacral	::	1½	:	1

This relation quite accords with the greater delicacy of the sense of touch in the upper extremity.

the lumbar and sacral nerves must descend from it almost perpendicularly through the lower part of the spinal canal. To this bundle of nerves the old anatomists have given the name of *cauda equina*, from its resemblance to a horse's tail.

CAUDA EQUINA.

To sum up briefly, it appears that the spinal cord consists of two symmetrical halves, separated in front and behind by a deep median fissure; that the two halves are connected at the bottom of the anterior fissure by an anterior or white commissure, at the bottom of the posterior fissure by the posterior or grey commissure; that each half of the cord is divided into three tracts or columns of longitudinal white nerve-fibres—an anterior, a lateral, and a posterior—the boundaries between them being the respective lines of origin of the roots of the spinal nerves; that the interior of the cord contains grey matter disposed in the form of two crescents, placed with their convexities towards each other, and connected by a transverse bar of grey matter, which constitutes the posterior commissure.

BLOOD-VESSELS OF THE CORD.

The cord is supplied with blood by—1. The *anterior spinal* artery, which commences at the medulla oblongata by a branch from the vertebral of each side, and then runs down the middle of the front of the cord. Other branches are derived from the vertebral, ascending cervical, intercostal, and lumbar arteries, which pass through the intervertebral foramina, and assist in keeping up the size of this anterior artery. 2. The *posterior spinal* arteries, which proceed also from the vertebral, intercostal, and lumbar arteries, and ramify somewhat irregularly on the back of the cord.

On the posterior part of the bodies of the vertebræ, the spinal arteries of opposite sides communicate by numerous transverse branches along the entire length of the spine, thus resembling the arrangement of its venous plexuses.

FUNCTIONS OF THE SPINAL CORD.

The spinal cord performs, at least, three functions:—1. It is the general conductor of impressions to, and from, the brain. 2. It transfers impressions. 3. It is a centre of reflex action. *Sensory* impressions are conducted by

the posterior roots of the spinal nerves to the cord, and are thence transmitted to the brain through the posterior columns and the grey matter of the cord. These impressions do not run up on the same side, for the fibres, immediately on entering the grey matter, cross over to the opposite side to reach the brain; so that if the posterior column of the *right* side be divided, the *left* leg, and not the right, would be deprived of sensation. *Motor* impulses are conveyed along the antero-lateral columns and the grey matter in them, and carry the commands of the will from the brain to the muscles. The crossing of the motor fibres takes place in the medulla oblongata, at the decussation of the anterior pyramids, so that they run in the corresponding half of the cord as far as their point of decussation. Division, therefore, of one half of the cord below this point, causes paralysis of motion on the same side of the body. The cord is, moreover, concerned in the conduction of impressions to and from the *vaso-motor centre* of the medulla oblongata, which determines the varying conditions of the blood-vessels. The cord also transfers impressions; this is more manifest in disease than in health; a well-marked example of transference is, that pain is felt at the knee in cases of disease of the hip-joint. The spinal cord has probably no power of originating impressions, in other words, it is *not automatic*.

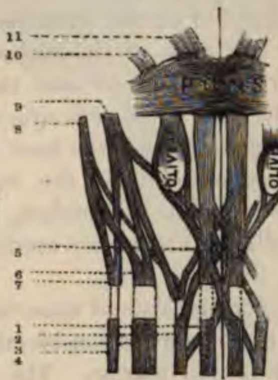
MINUTE STRUCTURE OF THE MEDULLA OBLONGATA AND PONS VAROLII. These are among the most complicated parts of the central nervous system. They contain white and grey nerve-matter intermixed. The white matter consists, in part, of the continuation upwards of the longitudinal fibres of the cord; in part, of horizontal fibres.

ANTERIOR PYRAMIDS. The anterior columns of the cord (fig. 158), having reached the lower part of the medulla oblongata, are not continued straight through it, but diverge from each other, being pushed aside by the deep fibres of the lateral columns, which here cross each other, and form the decussation of the anterior pyramids. In their further progress the fibres of the anterior columns are arranged thus: some of them run up, and form the outer portion of their own pyramid: some ascend

beneath the olive to join the restiform body; a third set pass upwards and, after embracing the olive, reunite, to form a single bundle; this, joined by fibres (olivary fasciculus) from the olive ascends under the name of the *fillet of Reil*, over the superior crus of the cerebellum to the corpora quadrigemina and the cerebral hemispheres (fig. 159).

The *lateral columns* on reaching the medulla oblongata are disposed off in three ways, as follows:—some of its fibres come forward between the diverging anterior columns, decussate in the middle line and form part of the pyramid of the opposite side;

Fig. 158.



1. Anterior column.
2. Lateral column.
3. Posterior column.
4. Posterior median column of the spinal cord.
5. Anterior pyramid.
6. Restiform body.
7. Posterior pyramid.
8. Fasciculus teres.
9. Inferior crus of the cerebellum.
10. To the corpora quadrigemina.
11. Crus cerebri.

DIAGRAM OF THE COURSE OF THE FIBRES THROUGH THE MEDULLA OBLONGATA.

others ascend with the restiform body (or tract) into the cerebellum; a third set ascends along the floor of the fourth ventricle (concealed by its superficial grey matter) as the *fasciculus teres*, and is continued along the upper part of the crus cerebri into the cerebrum.

Restiform Body. The posterior columns ascend (under the name of the restiform bodies), at the back of the medulla, diverge from each other, and are continued partly into the cerebellum, forming its inferior crura, and partly as the *fasciculi teretes* along the floor of the fourth ventricle into the cerebrum.

POSTERIOR PYRAMIDS. These are the continuations upwards of the posterior median columns of the cord; and, like the restiform body, each divides into two fasciculi, one of which ascends and helps to form the inferior crus of the cerebellum, the other runs up with the *fasciculus teres.*

HORIZONTAL FIBRES. The horizontal fibres in the medulla oblongata and the pons were first accurately described by Stilling and subsequently by Rolando. Some of them form a septum, and divide the medulla oblongata and pons into symmetrical halves; others, arising apparently from the septum, pass outwards in an arched manner through the lateral halves of the medulla; so that when seen in a transverse section by transmitted light, they describe a series of curves, with the convexity forwards, throughout the entire thickness of the medulla. Some of these transverse fibres appear on the surface over the pyramid and the olive; these have received the name of *arciform fibres of Rolando* (p. 584.) Stilling * and Kölliker,† who have studied the subject, are of opinion that they originate in the restiform bodies, and thence arch forwards—some on the surface, others through the substance of the medulla, and that they eventually join the fibres of the septum.

INTERNAL STRUCTURE OF THE PONS VAROLII. The pons consists of transverse and longitudinal white fibres, with a considerable quantity of grey matter in its interior. The superficial layer of fibres is obviously transverse, and connects the two hemispheres of the cerebellum. After removing the first layer, we expose the longitudinal fibres of the pyramids in their course to the crura cerebri; these longitudinal fibres, however, are intersected by the deep transverse fibres of the pons, which, like the superficial, are continued into the cerebellum. The deepest layer of the pons consists entirely of longitudinal fibres, derived partly from the lateral columns, partly from the restiform bodies of the medulla.

CRURA CEREBRI. These are composed of longitudinal fibres, derived from the pyramids, from part of the lateral

* 'Ueber die Medulla Oblongata,' Erlangen, 1843.

† 'Mikroskopische Anatomie,' p. 454.

and restiform columns of the cord, and from the grey matter in the pons Varolii. If one of the crura be divided longitudinally, there is found in the middle of it a layer of dark-coloured nerve-substance, called *locus niger*, which separates the crus into an upper and lower stratum of fibres. The lower stratum is tough and coarse, and consists of the continuation of the fibres pro-

Fig. 159.

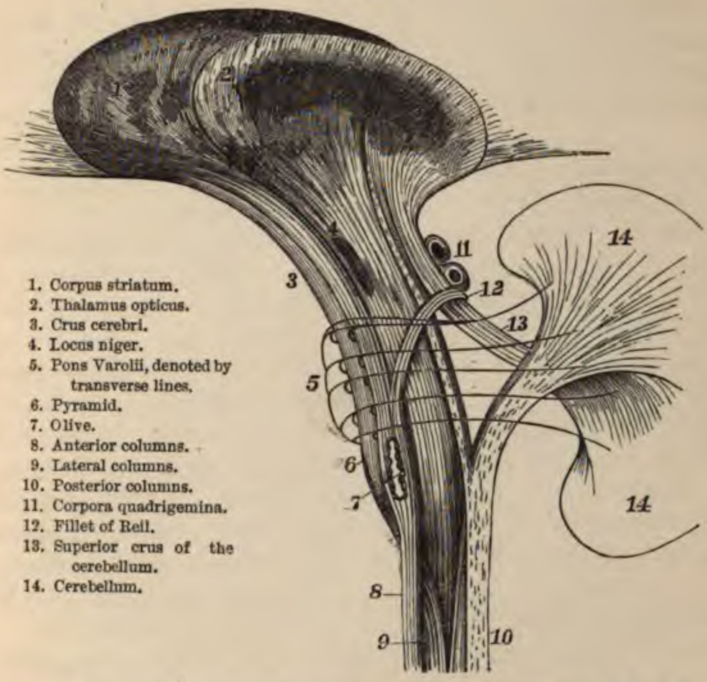


DIAGRAM OF THE COURSE OF THE FIBRES THROUGH THE MEDULLA AND PONS.

ceeding from the pyramid and the pons. The upper stratum is much softer and finer in texture, and has received the name of *tegmentum*: it is composed of the fibres proceeding from the lateral and restiform columns; also from the superior crus of the cerebellum. Tracing the fibres of the crus cerebri into the

cerebral hemisphere, we find that its lower fibres ascend chie through the corpora striata, its upper fibres through the thala optici. In passing through these ganglia, the crus receives large addition to its fibres: these branch out widely towa all parts of the hemisphere, in order to reach the cortical su stance on the surface.

DISSECTION OF THE EYE.

SINCE the eye in the human subject cannot be obtained sufficiently fresh for anatomical purposes, the student should examine the eye of the sheep, bullock, or pig. The conjunctiva membrana should be removed, together with the loose connective tissue which unites it to the sclerotica.

CONJUNCTIVA. The conjunctiva is the mucous membrane which covers the ocular surface of the eyelids and the anterior part of the globe, and is lined with columnar epithelium. It is loosely attached to the sclerotic coat, so as not to impede the movements of the globe. The *palpebral* portion of it is very vascular, and provided with fine papillæ abundantly supplied with nerves.* It is continued into the Meibomian glands, the puncta lachrymalia, and the ducts of the lachrymal gland. The *sclerotic* portion is thinner and has no papillæ. It is transparent and nearly colourless, except when inflamed; it then becomes intensely vascular, and of a bright scarlet colour. An abundant supply of nerves is distributed to the membrane; their arrangement is stated to be the same as that of the skin, but many of them have been described as terminating in end-bulbs.

The *corneal conjunctiva* is composed chiefly of epithelium, arranged in layers. This portion of the conjunctiva cannot be separated by dissection in recent eyes, but it possesses the same acute sensibility as the rest of the conjunctiva. Changes produced by inflammation of the conjunctiva often involve the cornea and render its texture thick and opaque.† Blood-vessels ramify

* These papillæ were first described by Eble, 'Ueber den Bau und die Krankheiten der Bindehaut des Auges.'

† The facts of comparative anatomy confirm this view. In the serpent tribe,

round the margin of the cornea, forming a network arranged in loops. Lymphatics exist abundantly in the palpebral and sclerotic conjunctiva, and communicate, after becoming much reduced in size, with the irregular cell-spaces of the cornea.

The human eye is nearly spherical, the antero-posterior and vertical diameters being equal, the transverse exceeding these by less than half a line. The convexity of the cornea varies in different persons, and at different periods of life; this is one cause of the several degrees of near sight and far sight.

COATS AND HUMOURS OF THE EYE. The globe is composed of three coats, arranged one within the other, which enclose certain transparent structures. The external coat, consisting of the *sclerotic* and *cornea*, is fibrous, thick, and strong. The second coat, consisting of the *choroid*, the *iris*, and the *ciliary processes*, is composed of blood-vessels, muscular tissue, and pigment-cells, and is very dark in colour. The third coat, called the *retina*, consists of the expansion of the optic nerve for the reception of the impression of the waves of light. The bulk of the interior is filled with a transparent humour, called the *vitreous body*. Embedded in the front of this, and just behind the pupil, is the crystalline lens, for the purpose of concentrating the rays of light. In front of the lens is placed a moveable curtain, called the *iris*, to regulate the amount of light which shall be admitted through a central aperture, the *pupil*, to the fundus of the eye. The space in which the iris is suspended is filled with a fluid, termed the *aqueous humour*.

SCLEROTIC COAT. The sclerotic is the tough protecting coat of the eye, and consists of white fibres interlacing in all directions.* It covers about five-sixths of the globe, the remaining

which annually shed the skin, the front of the cornea comes off with the rest of the external surface of the body. In the eel the surface of the cornea is often drawn off in the process of skinning. In some species of rodents which burrow under the ground like the mole, the eye is covered with hair, like other parts.

* The sclerotic coat of the eye in fishes is of extraordinary thickness and density; and, in birds, this coat is further strengthened by a circle of bony plates, fourteen or fifteen in number, arranged in a series round the margin of the cornea. Similar plates are found in some of the reptiles, and particularly in the fossil ichthyosauri and plesiosauri.

one-sixth being completed by the cornea. The thickest part of the sclerotic coat is at the back of the globe (fig. 161); the thinnest is a short distance behind the cornea.* The back of the sclerotic is perforated by the optic nerve, which enters it about one-tenth of an inch on the nasal side of the axis of vision. The optic nerve at its entrance into the sclerotic is much constricted, and instead of passing through a single aperture in this coat, enters it through a porous network of fibrous tissue, called the *lamina cribrosa.*† The sheath of the optic nerve becomes continuous with the sclerotic where it perforates this coat. Around the optic nerve the sclerotic is perforated by the ciliary arteries, veins, and nerves, for the supply of the choroid and iris. About a quarter of an inch from the cornea the sclerotic receives the insertion of the recti muscles; here also it transmits the anterior ciliary arteries, which run forward along the tendons of these muscles, and form a vascular ring around the margin of the cornea (fig. 160).

Fig. 160.

INSERTION OF THE RECTI MUSCLES WITH ANTERIOR CILIARY ARTERIES.

The sclerotic is composed of connective tissue arranged in bundles, which run, some longitudinally, some transversely. The longitudinal fibres are the most external and abundant. Under the microscope numerous connective-tissue corpuscles may be seen filling cell-spaces, similar to those found in the cornea, but not so abundant, and containing pigment-granules. Between these may be demonstrated fine elastic fibres. The inner surface of the sclerotic is coated with a thin layer of connective tissue, *lamina fusca,* in which are found some pigment-cells.

To examine the cornea, it should be removed with the sclerotic

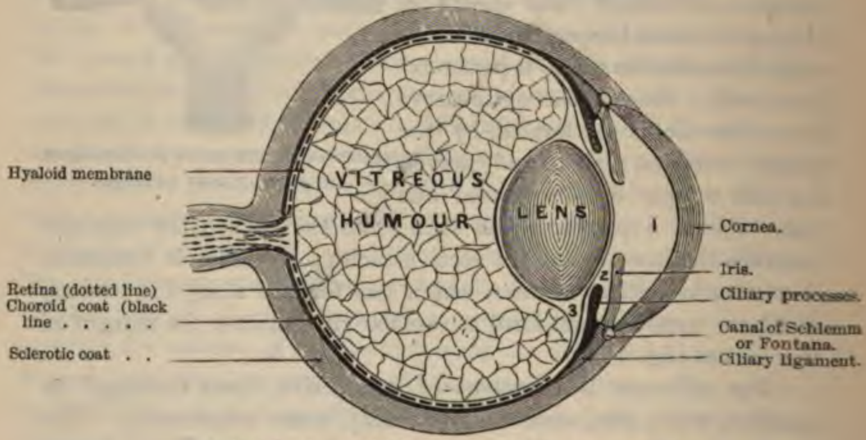
* The greatest thickness posteriorly is about the $\frac{1}{25}$th of an inch; its least thickness in front is about $\frac{1}{40}$th of an inch.

† In the centre of the lamina cribrosa is an opening larger than the rest, which transmits the arteria centralis retinæ.

coat. This should be done under water, by making a circular cut with scissors, about a quarter of an inch from the margin of the cornea. With a little care it will be easy to remove the outer coat of the eye without injuring the dark choroid coat, the ciliary muscle, or the iris. In the loose brown-coloured connective tissue between the sclerotic and the choroid are the ciliary nerves passing forwards to the iris; their white colour makes them very conspicuous on the dark ground.

CORNEA. The cornea is the brilliant translucent coat which forms about the anterior one-sixth of the globe. It

FIG. 161.



1. Anterior chamber filled with aqueous humour.
2. Posterior chamber. 3. Canal of Petit.

DIAGRAM OF A VERTICAL SECTION OF THE EYE.

is nearly circular in shape, its diameter being nearly half an inch, and its thickness about $\frac{1}{25}$ of an inch. The curve of the cornea forms part of a smaller circle than that of the sclerotic, so that it projects further forwards, varying in this respect in different eyes, and at different ages of life. It is firmly connected at its margin to the sclerotic, with the fibres of which it is continuous. The margin of the sclerotic is bevelled on the inside; that of the cornea on the outside, so that the former overlaps the latter (fig. 161).

STRUCTURE.

The cornea consists of five layers, which are not all composed of the same kind of tissue. The most *superficial layer* is the conjunctival. This consists of several strata of epithelial cells; the deeper ones, the more numerous, are columnar and placed vertically, the superficial ones are flattened scaly epithelium cells, with well-marked nuclei. The *second layer* is about the $\frac{1}{1500}$ of an inch thick, and consists of a perfectly structureless lamina, which, when peeled off, has a remarkable tendency to curl. Boiling, or the action of acids, does not render it opaque, like the other layers of the cornea. The *third layer* (*cornea proper*) consists of translucent connective tissue, upon which the thickness and strength of the cornea mainly depend. The fibres are arranged in layers, about sixty in number. Between the laminæ are irregularly branched spaces, called the *cell-spaces of the cornea.* In these spaces are lodged the *corneal corpuscles*, with outstanding processes, which communicate freely with each other, and correspond in shape to the spaces within which they lie. In inflammation of the cornea these corpuscles undergo considerable changes.* The *fourth layer* is translucent, elastic and brittle, and may be easily separated from the preceding laminæ. Like the second layer, it is unaffected by boiling or by the action of acids or alkalies, but is somewhat thinner, being from $\frac{1}{2000}$ to $\frac{1}{3000}$ of an inch in thickness. It is termed the *membrane of Descemet.* In the sclerotic coat, close to its junction with the cornea, is situated a small oval canal, lined with epithelium, termed the *sinus circularis iridis*, or *canal of Schlemm* (fig. 161). It is probably a venous sinus, for it can always be injected from the arteries. The *fifth layer* consists of a single layer of polygonal epithelial cells, resembling those which line serous membranes.† In its healthy state the cornea contains no

* If fluid be injected very gently into the cornea proper, there may be demonstrated a system of canals, called *Recklinghausen's canals*, which are the communications between the corneal corpuscles; but if the fluid be injected more forcibly, it passes in the course of the fibres composing the various laminæ of the cornea, which gives the appearance of a number of varicose and enlarged tubes crossing each other at right angles: these are termed *Bowman's corneal tubes.*

† For a detailed description of the structure see Todd and Bowman, 'Physiological Anatomy.'

blood-vessels, except at its circumference, where they form loops. Its nerves, which are numerous, forty to forty-five in number, may be traced forwards in the transparent tissue as a fine plexus; this gives off minute fasciculi, which ramify beneath the epithelium, constituting the sub-epithelial plexus. From this very minute filaments run between the epithelium cells, forming the intra-epithelial plexus.

CHOROID COAT. After the removal of the sclerotic and cornea, we expose the *choroid coat*,* and its continuation formerly known as the *ciliary processes*. In connection also with this tunic is a white ring, the *ciliary muscle*.

The choroid is the soft and flocculent tunic of the eye, recognised by its dark brown colour and great vascularity. Posteriorly there is a circular aperture in it for the passage of the optic nerve. In front, the choroid passes beneath the ciliary muscle with which it is connected, and then extends forwards, terminating in a series of plaited folds, called the *ciliary processes*. It is connected with the sclerotic by delicate connective tissue, the *lamina fusca*, through which the ciliary vessels and nerves pass forwards.

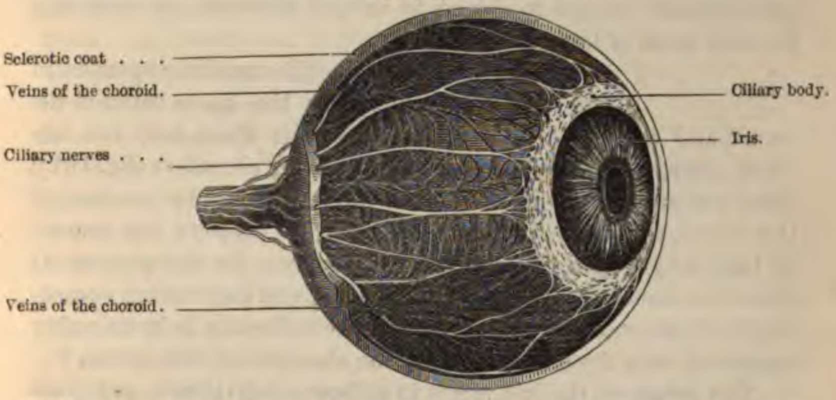
CILIARY PROCESSES. The *ciliary processes* are the folds formed by the anterior part of the choroid, and may be best seen when the globe has been divided by a vertical section into an anterior and a posterior half, the vitreous humour being left undisturbed. They are black, and consist of from sixty to seventy radiating folds, arranged in a circle about three lines broad. These processes consist of longer and shorter folds, the former being the more numerous. The longer fold is about a line in length; the smaller about half a line. One of the longer ones is seen in the diagram, p. 634. The processes fit into corresponding folds of the suspensory ligament of the lens, and their free ends project for a short distance into the posterior chamber. The vascular supply of the ciliary processes is most abundant, and resembles in the main that of the choroid. The arteries come

* So called because its outer flocculent surface somewhat resembles the chorion, or external investment of the ovum.

chiefly from the anterior ciliary, and from the front vessels of the choroid; and after breaking up into a fine plexus, they form loops which arch backwards to end in the smaller veins. Their dark colour arises from pigmented cells, which disappear, however, at the free ends of the processes.

Under the microscope the choroid is seen to consist of two layers, both composed of blood-vessels held together by fine connective tissue, in which are found large ramified pigment-cells. The *outer layer* consists of the larger branches of the blood-vessels; the

FIG. 162.



SCLEROTIC COAT REMOVED TO SHOW THE CHOROID, CILIARY LIGAMENT, AND NERVES.

arteries (short ciliary) being chiefly on the inner, the veins on the outer, surface. The veins are arranged with great regularity in drooping branches (*vasa vorticosa*), like a weeping-willow (fig. 162), and converge to four or five nearly equidistant trunks, which, after running backwards for a short distance, perforate the sclerotic not far from the entrance of the optic nerve, and empty themselves into the ophthalmic vein. The *inner layer* is formed by the capillaries of the ciliary arteries, and is called, after the Dutch anatomist Ruysch, '*tunica Ruyschiana*.' It consists of the most delicate vascular network found in any tissue, and extends forwards to the ciliary processes, with the capillaries of which it freely communicates.

Between the choroid membrane and the lamina fusca of t sclerotic is a layer of connective tissue, the *lamina supra ch roidea*, which serves to connect the two tunics.

CILIARY MUSCLE. This muscle consists of unstriped fibres, a arises by a thin tendon from the sclerotic close its junction with the cornea. Thence its fibres radiate backwar and are lost in the choroid behind the ciliary processes. So of these fibres form a circular muscle around the outer circu ference of the iris, constituting the circular ciliary muscle, whi was formerly described as the ciliary ligament. Its action is accommodate the eye to objects at various distances, by renderi the lens more or less convex.*

IRIS. The iris is the contractile curtain suspended the clear fluid, which fills the space between t cornea and the lens. The iris divides this space into two u equal parts, called the *anterior* and *posterior chambers* (fig. 161 these communicate with each other through a circular aperture the centre, called the *pupil*.† Its use is to regulate the amou of light which shall be admitted into the eye: for this purpose i inner circumference is capable of dilating and contracting accor ing to circumstances, while its outer circumference is immoveabl connected with the ciliary muscle, the choroid and the cornea. ‡

The colour of the iris varies in different individuals, and giv the peculiar tint and brilliancy to the eye. The colouring matt or pigment is contained in minute cells (*pigment cells*), lining th anterior and posterior surfaces of the iris, the posterior taking th name of *uvea* from its grape-like colour. Pigmented cells ar also found in the substance of the iris.

When the iris is laid under water, and viewed with a low mag nifying power, it is seen to be composed of fine fibres convergin from all sides towards the pupil; many of them unite and forr

* Sir Philip Crampton has noticed that this muscle is well developed in bird In them its fibres are of the striped variety, just as the circular fibres of the iris ar

† The size and shape of the pupil vary in different animals. In the bulloc sheep, horse, etc., it is oblong; in carnivorous quadrupeds it is often a mere vertic slit during the day, but dilates into a large circle at night.

‡ The diameter of the pupil in man varies from the $\frac{1}{20}$th to the $\frac{1}{3}$ of an inch.

arches, leaving elongated interspaces, which are most marked towards the middle of the iris.

The contractile power of the iris depends upon muscular fibres of the non-striped kind, arranged some in a radiating, others in a circular manner. The radiating (*dilatator iridis*) converge towards the pupil, where they form arches and blend with the circular fibres; the circular (*sphincter*), well marked, are collected on the posterior aspect of the pupillary margin, where they form a ring about $\frac{1}{40}$th of an inch in width.*

A considerable amount of connective tissue is present in the iris, forming the *stroma*, and consists of circular and radiating fibres; the circular are found at the circumference of the iris, the radiating converge towards the pupil. In front of the iris is a thin layer of epithelium, which is continuous with that covering the membrane of Descemet.

When minutely injected, the iris appears to be composed almost entirely of blood-vessels; they form, in the ciliary muscle at the outer circumference of the iris, a vascular circle (the *circulus major*), from which numerous small branches pass inwards, and form another circle (*circulus minor*), which terminates in the veins of the iris.

Its blood-vessels are derived from two sources—the posterior or long, and the anterior ciliary arteries. The *long ciliary* arteries, two in number, perforate the sclerotica on each side of the optic nerve, and then run forwards upon the choroid to the ciliary muscle; here they divide into branches constituting the circulus major, just described: the *anterior*, five or six in number, are derived from the muscular branches, and ramify on the tendons of the recti muscles (p. 212), where they perforate the sclerotica behind the margin of the cornea. These vessels supply the ciliary processes and iris, and it is from their enlargement that the red zone round the cornea is produced in inflammation of the iris.

CILIARY NERVES. The nerves of the iris, about fifteen in number, proceed from the lenticular ganglion, and from

* The circular fibres of the iris in the bird are of the striped variety, and discernible without difficulty.

the nasal branch of the ophthalmic division of the fifth ner (p. 213). They perforate the back of the sclerotica like tl arteries, run along the choroid which they supply in their cours and then break up into a fine non-medullated plexus, whic supplies the ciliary muscle and iris.

Membrana Pupillaris. Until the seventh or eighth month of fœt life, the pupil is closed by a delicate membran the *membrana pupillaris*. Its vessels, derived from those the iris and capsule of the lens, are arranged in loops whic converge toward the centre of the membrane. Quekett ha described this membrane, which has always been regarded a a distinct structure, as identical with the anterior layer of th capsule of the lens.*

Retina. To obtain a view of the retina, the choroi coat must be carefully removed while the eye i under water; this should be done with the forceps and scissor on a fresh eye. The optic nerve, having entered the interior of th globe through the sclerotic and the choroid, expands into the deli cate nervous tunic called the retina. In passing through th coats of the eye the nerve becomes gradually constricted an reduced to one-half of its diameter; here it presents a roun disk, called the *porus opticus*, in the centre of which may be see the arteria centralis retinæ. At this point, too, the nerve-sub stance projects slightly into the interior of the globe, forming little prominence, to which the term *colliculus nervi optici* has bee applied.† In front the retina terminates a little behind the poste rior margin of the ciliary processes in a thin serrated border (*or serrata*).

Precisely opposite the pupil, in the centre of the axis o vision, there is an oval yellow spot, *macula lutea*, in the retina about $\frac{1}{20}$th of an inch in diameter, fading off gradually at th edges, and having a black spot, *fovea centralis*, in the centre

* See a paper by John Quekett in the 'Transactions of the Microscopical Societ of London,' vol. iii. p. 9.

† This prominence is remarkable in that it is insensible to the rays of light. It i termed the 'blind spot.'

Here vision is the most perfect; so then it might be called the "spot of sight." This central spot was believed by its discoverer, Sömmering, to be a perforation; but it is now ascertained to be due to the pigmentary layer of the retina showing through it. These appearances are lost soon after death, and are replaced by a

Fig. 163.

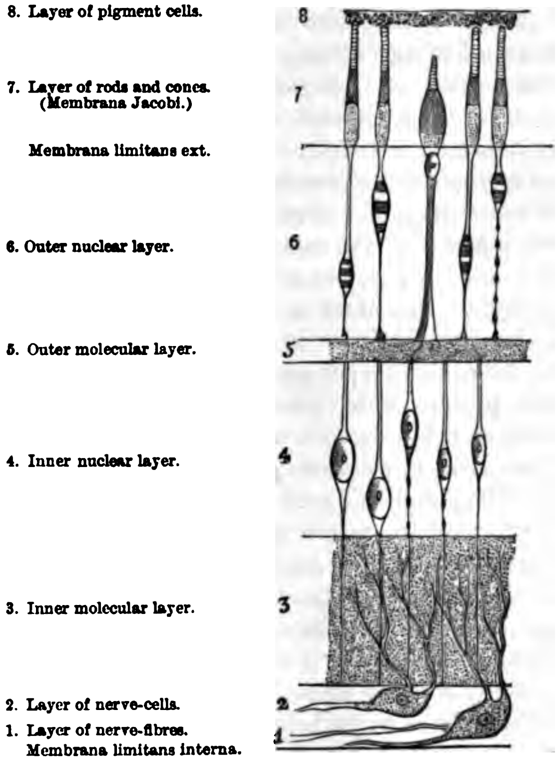


DIAGRAM OF THE VARIOUS LAYERS OF THE RETINA. (After Quain.)

minute fold, into which the retina gathers itself, reaching from the centre of the spot to the prominence of the optic nerve.*

* In birds the retina has throughout the yellowish colour seen only at one part in the human eye.

Minute Structure of the Retina. Although to the naked eye the retina appears a simple, soft, semi-transparent membrane, yet, when examined under the microscope, it is found to be most minutely and elaborately organised. It varies in thickness from the $\frac{1}{50}$ to the $\frac{1}{200}$ of an inch, being thickest behind and gradually diminishing towards the front. It consists of eight layers, through which may be traced a considerable amount of extremely delicate connective tissue (fibres of Müller), which constitutes a scaffolding for the various strata, and is said to form for them two more or less continuous boundary lines termed *membranæ limitantes*, *interna* and *externa*. The layers are as follows, beginning from within:—

1. The *layer of nerve-fibres* is composed of the spreading out of the optic nerve-fibres and of connective-tissue cells. The nerve-fibres, consisting only of the axis-cylinders, run forwards as a continuous layer, and, in fact, become connected with the nerve-cells of the next layer. The fibres are absent on the yellow spot.

2. The *ganglionic layer* is a single stratum of spheroidal nerve-cells: from the deeper part of each cell there is given off an elongated process, which passes obliquely into the nerve-fibre layer, with which it becomes incorporated; from the opposite side of the cell two or more processes pass outwards and become lost in layer No. 3. The ganglionic cells which, in the greater extent form a single layer, are at the yellow spot arranged eight or ten deep.

3. The *inner molecular layer* is a granular stratum of considerable thickness, with a structureless matrix. In it are found, also, the processes of the cells of the preceding layer, and some varicose filaments which pass inwards from the next stratum.

4. The inner nuclear layer is said to contain three or four kinds of cells, some of which belong to the *Müllerian* or connecting tissue fibres of the retina; others, the more numerous, are bipolar nerve-cells. It is hard to give an intelligible description of this layer, so long as even experts make such different statements concerning it.

5. The *outer molecular or internuclear layer* resembles in most respects the inner molecular layer, but is much thinner.

6. The *outer nuclear layer* consists of a considerable thickness of nucleated cells, with an outward and an inward filament, which may be recognised as connected respectively with the rods and cones of the next layer. The rod-granules are the most numerous, and each has an enlargement which presents a well-marked transverse striation; from this enlargement one varicose filament passes inwards and becomes connected with the outer molecular layer; the other becomes continuous with a rod. The cone-granules are fewer and thicker, and, like the rod-granules, one end terminates in the outer molecular layer, the other passes into the base of a cone.

7. The *rods and cones, bacillary layer*, or *Jacob's membrane*, is composed of minute cylindrical elements arranged at right angles to the surface of the retina. The *rods*, the more numerous, are tapering processes running through the whole thickness of this layer, and externally are embedded to a greater or less depth in the pigmental layer, so that when viewed from without they have the appearance of mosaic pavement. Among the rods are intermingled numerous shorter flask-shaped bodies, called *cones*; their outer extremities taper off towards the choroid, their inner broad ends are connected with the fibres of Müller and the outer nuclear layer. The rods are absent at the yellow spot.

8. The *pigmentary layer* is usually described as forming part of the choroid coat, but it should be included more properly as one of the layers of the retina. It consists of a single layer of hexagonal nucleated cells filled with pigment-granules, which are most numerous towards the margins of the cells. The use of the pigment is to absorb the rays of light which pass through the retina, and thus prevent their being reflected. It serves the same purpose as the black paint with which the inside of optical instruments is darkened. Albinoes, in whom this layer has little or no pigment, are, consequently, dazzled by daylight and see better in the dusk.*

* In many of the nocturnal carnivorous quadrupeds, the inner surface of the choroid at the bottom of the eye presents a brilliant colour and metallic lustre. It is called the *tapetum*. By reflecting the rays of light a second time through the

The *arteria centralis retinæ*, after emerging through the porus opticus, divides into two branches—an upper and a lower—which then form a delicate network of blood-vessels throughout the nerve-fibre layer, penetrating as far as the inner nuclear layer, beyond which no capillaries can be traced. After maceration in water, the nervous substance can be removed with a camel's hair brush, and then in an injected eye the network formed by the vessels can be distinctly seen. The arteries of the retina do not communicate directly with the choroidal vessels.

STRUCTURE OF THE MACULA LUTEA AND FOVEA CENTRALIS. The various layers of the retina are thinner at the fovea, except the cones, which are much elongated. It is destitute of rods and of the nerve-fibre layer. At the margin of the fovea most of the layers are thicker than elsewhere.

AQUEOUS HUMOUR. The aqueous humour consists of a few drops of an alkaline clear watery fluid, which fills the space between the cornea and the lens.* The iris lies in it, and divides the space into two chambers of unequal size—an anterior and a posterior. The posterior is much the smaller of the two; indeed, the iris rests on the capsule of the lens, so that, strictly speaking, there is no interval between the opposed surfaces, hence no such space really exists. This accounts for the frequent adhesions which take place during inflammation of the iris, between the iris and the capsule of the crystalline lens.† A delicate layer of epithelium covers the posterior surface of the cornea, but nothing like a continuous membrane can be demonstrated on the iris or the capsule of the lens. The anterior chamber is remarkable for the rapidity with which it absorbs and secretes, as is proved, in the one case, by the speedy removal of extravasated blood; in the other, by the rapid reappearance of the aqueous humour after the extraction of a cataract.

retina, it probably enables the animal to see better in the dusk. It is the cause of the well-known glare of the eyes of cats and other animals; and the great breadth of the luminous appearance arises from the dilatation of the pupil.

* The solid constituent is mainly composed of chloride of sodium.

† Some anatomists describe the anterior chamber as lined by a serous membrane called the membrane of the aqueous humour.

THE VITREOUS BODY AND THE HYALOID MEMBRANE.

The vitreous body is a transparent, gelatinous-looking substance, which fills up nearly four-fifths of the interior of the globe (p. 634). It can be easily separated from the retina, except at the optic disc; in front it presents a deep depression, in which the crystalline lens is embedded. It is surrounded by a delicate transparent membrane, the *hyaloid membrane*, which forms a capsule for the vitreous body, and is sufficiently strong to keep it in shape after the stronger tunics of the eye have been removed.

When the vitreous humour has been hardened in chromic acid it is rendered somewhat opaque, and presents, especially at its outer part, a lamellar appearance. It consists of a fluid contained in the meshes of a cellular structure, which communicate freely with each other; for if any part of it be punctured, the humour gradually drains away.* If examined carefully, the lamellation is seen to be arranged concentrically, the layers, as they approach the centre, becoming less firm in consistence. The vitreous, moreover, on a transverse section shows a radial striation, but whether this exists naturally, or is the result of post-mortem changes, or from chemical reagents, is not known. Running through the middle from before backwards is a small canal—*canal of Stilling*—about a line in diameter, which contains fluid, and is broader behind than in front; this in the fœtus lodges a small branch of the retinal artery, which ramifies on the back of the capsule of the lens.

FIG. 164.

ARTERIES OF THE RETINA.

Canal of Petit (inflated).
Zone of Zinn (exaggerated).

ZONE OF ZINN.

Surrounding the hollow in the vitreous which receives the crystalline lens is the *zone of Zinn*.† This zone is best exposed by removing the ciliary processes. It appears as a dark, radiating disk, and extends from the front margin of the retina nearly to the capsule of the lens;

* This is composed mainly of water, with albuminate of soda, and mucin.

† Zinn was Professor of Anatomy at Göttingen about the middle of the eighteenth century, and author of 'Descriptio Anat. Oculi Humani.'

its surface is marked by prominent ridges, which correspond wit[h] the intervals between the ciliary processes (fig. 164). It assist[s] in maintaining the lens in its proper position, and is firml[y] connected with its capsule.

CANAL OF PETIT.

If the transparent membrane between the zon[e] of Zinn and the margin of the lens be carefull[y] punctured, and the point of a small blow-pipe gently introduce[d] and air or fluid injected, we may succeed in inflating a canal whic[h] encircles the lens: this is the *canal of Petit*, or '*canal godronné*' (fig. 164). This canal is usually described as formed by th[e] separation of the hyaloid membrane into two layers; the anterio[r] —the zone of Zinn—being continued forwards in front of the len[s]; the posterior passing behind it.

CRYSTALLINE LENS.

The crystalline lens (fig. 161) is a perfectl[y] translucent solid body, situated immediately be-hind the pupil, and partly embedded in the vitreous body. It i[s] convex on both sides, but more so behind. In early life it i[s] nearly spherical and soft, but it becomes more flattened, firmer, an[d] amber-coloured with advancing age. In the adult its transvers[e] diameter is about one-third of an inch; its antero-posterior, one-fifth of an inch.

The lens is surrounded by a capsule equally translucent a[s] itself. The capsule is brittle, and is composed of a structur[e] similar to the elastic layer of the cornea. It is four times thicke[r] in front than behind, as might be expected, for the sake of mor[e] effective support. No vascular connection whatever exists betwee[n] the lens and its capsule.* The lens protrudes directly the capsul[e] is sufficiently opened.

MINUTE STRUCTURE OF THE LENS.

The minute structure of the lens can only be made out after being hardened. It is soft, almost gelatinous in consistence outside, but each suc-

* The vessel of the capsule of the lens is derived from the arteria centralis retinæ, and in mammalia can only be injected in the fœtal state. In the reptilia, however, the posterior layer of the capsule is permanently vascular. This small artery passes forwards through the canal of Stilling to the posterior part of the capsule of the lens, on which it radiates into numerous small branches, communicating with branches in the iris and pupillary membrane.

cessive layer becomes more dense, so that the central part is hard, and constitutes the nucleus. It is seen to be divided into three equal parts, by three lines, which radiate from the centre to within one-third of the circumference. Each of these portions is composed of numerous concentric layers, arranged one within the other, like the coats of an onion. If any single layer be examined with the microscope, it is seen to be composed of fibres about $\frac{1}{5000}$th of an inch in thickness, running in a curved direction, and connected together by finely serrated edges. On a transverse section the lens fibres are found to be hexagonal prisms, with very little connecting substance. Between the front of the lens and its capsule is a layer of flattened cells with well-marked excentric nuclei. The beautiful dove-tailing of the fibres of the lens was first pointed out by Sir David Brewster; and to see it in perfection, one ought to examine the lens of the cod-fish.

The function of the lens is to bring the rays of light to a focus upon the retina.*

* The lens contains about 60 per cent. of water, and 30 per cent of albuminoids.

DISSECTION OF THE ORGAN OF HEARING.

The parts constituting the organ of hearing should be examined in the following order:—1. The outer cartilage or pinna; 2. The meatus auditorius externus; which leads to 3. The tympanum or middle ear; and 4. The labyrinth or internal ear, comprising the vestibule, cochlea, and semi-circular canals.

PINNA. The *pinna* or *auricle* is irregularly oval, and presents on its external aspect numerous eminences and hollows, which have received the following names:—The circumferential folded border is called the *helix*; the ridge within it, the *antihelix*; between these is a curved groove, called the *fossa of the helix*. The antihelix bifurcates towards the front, and encloses the *fossa of the antihelix*. The conical eminence in front of the meatus is termed the *tragus*, on which some hairs are usually found. Behind the tragus, and separated from it by a deep notch (*incisura intertragica*), is the *antitragus*. The *lobule* is the soft pendulous part, and consists of fat and fibrous tissue. The deep hollow, which collects the vibrations of sound, and conveys them into the external meatus, is termed the *concha*. The pinna is composed of yellow fibro-cartilage, with a little fat and cellular tissue. It is attached by an *anterior ligament* to the root of the zygoma, and by a *posterior* to the mastoid process of the temporal bone. When the skin of the pinna is removed, we find that the cartilage has a tubular prolongation inwards, which forms the external part of the meatus auditorius. It does not, however, form any part of the lobule, and is incomplete behind the tragus, the deficiency being filled up with fibrous tissue. The cartilage further presents several fissures (*fissures of Santorini*) at the anterior part of the tubular prolongation, which are completed by firm fibrous tissue.

MUSCLES OF THE PINNA. The muscles which move the cartilage of the ear as a whole, have been described (p. 2). Other small muscles extend from one part of the cartilage to another; but they are so indistinct that, unless the subject be very muscular, it is difficult to make them out. The following six—four on the front of the auricle and two behind it—are usually described:—

(*a*) The *musculus major helicis* runs vertically along the front margin of the helix.

(*b*) The *musculus minor helicis* lies over that part of the helix which is connected with the concha.

(*c*) The *musculus tragicus* lies vertically over the outer surface of the tragus.

(*d*) The *musculus antitragicus* passes transversely from the antitragus to the lower part of the antihelix.

(*e*) The *musculus transversus* is on the cranial aspect of the pinna; it passes nearly transversely from the back of the concha to the helix.

(*f*) The *musculus obliquus* extends vertically from the cranial aspect of the concha to the convexity below it.

The arteries of the pinna are derived from the posterior auricular, and from the auricular branches of the temporal and occipital. The veins empty themselves into the temporal vein. The nerves are furnished by the auriculo-parotidean branch of the superficial cervical plexus, the auriculo-temporal branch of the inferior maxillary, the posterior auricular branch of the facial, and the auricular branch of the pneumogastric.

MEATUS AUDITORIUS EXTERNUS. This passage leads down to the membrana tympani, and conveys the vibrations of sound to the tympanum. It is about an inch and a quarter in length; its external opening is longest in its vertical direction: its termination is broadest in its transverse. The canal inclines at first upwards and forwards, and then curves a little downwards.* Its

* To obtain a correct knowledge of the length and dimensions of the meatus, sections should be made through it in different directions, or a cast be taken of it in plaster-of-Paris.

floor, owing to the oblique direction of the membrana tympani, a little longer than the roof. It is not of equal calibre throughou the narrowest part being about the middle; hence the difficult of extracting foreign bodies which have passed to the bottom of th canal. It is formed, partly by a tubular continuation of th cartilage of the auricle, partly, by an osseous canal in the tempor bone. The *cartilaginous portion* is about half an inch long an is firmly connected with the *osseous portion*, which is about thre fourths of an inch. The skin and the cuticle are continued dow the passage, and becoming gradually thinner, form a cul-de-sa over the membrana tympani. The outer portion is furnished wit hairs and ceruminous glands which secrete the cerumen or wa and are only found over the cartilaginous portion of the canal. It arteries are derived from the posterior auricular, internal maxillar and temporal; its nerve from the auriculo-temporal.

TYMPANUM. The *tympanum*, or middle ear, is an irregula cavity in the petrous part of the temporal bon and separated from the external auditory meatus by the membran tympani. It is lined with mucous membrane and filled with ai which is freely admitted through the Eustachian tube; so tha the atmospheric pressure is equal on both sides of the membran A chain of small bones, retained in their position by ligament and acted upon by muscles, passes across it. The use of the bones is to communicate the vibrations of the membrana tym pani to the labyrinth. For this purpose one end of the chain attached to the membrane, the other to the fenestra ovalis. Th antero-posterior diameter of the tympanum is rather less than ha an inch, its vertical and transverse diameters about a quarter of a inch. The cavity is bounded by a roof, a floor, an outer, an inne an anterior, and a posterior wall. Its *roof* is formed by a thi plate of bone corresponding with the anterior surface of the pa petrosa; its *floor*, by a thin plate, which forms the jugular foss Its *outer wall* is formed by the membrana tympani, and partly b bone; the latter is pierced by the fissura Glaseri (which gives passag to the processus gracilis of the malleus and the laxator tympani and by the canal of Huguier for the exit of the chorda tympa

nerve. The *inner wall* presents the following objects, beginning from above: 1. A *ridge*, indicating the line of the aqueductus Fallopii; 2. The *fenestra ovalis*, which leads into the vestibule, but is closed in the recent state by a membrane, to which is attached the base of the stapes; 3. Below the fenestra ovalis is a bony prominence, the *promontory*; it is occasioned by the first turn of the cochlea, and is marked by grooves, in which lie the branches of the tympanic plexus of nerves; 4. Below and behind this, is the *fenestra rotunda*; it leads into the scala tympani of the cochlea, but is closed in the recent state by membrane; 5. Immediately behind the fenestra ovalis, is a small conical eminence, named the *pyramid*, in the summit of which is a small aperture, from which the tendon of the stapedius emerges.

The *posterior wall* presents three or four openings, which lead into the mastoid cells, and convey air into them from the tympanum; also a small foramen, *foramen chordæ posterius*, for the passage of the chorda tympani nerve.

The *anterior wall* leads to the *Eustachian tube*, and (in the dry bone) to the *canal for the tensor tympani*, which are separated from each other by a bony septum, the *processus cochleariformis*.

Lastly, a nerve called the chorda tympani (a branch of the portio dura) runs across the cavity, covered by mucous membrane.

MEMBRANA TYMPANI. The *membrana tympani* is a thin semi-transparent disk which completely closes the bottom of the meatus auditorius externus. It is nearly circular, and its circumference is set in a bony groove, so that it is stretched, somewhat like the parchment of a drum, on the outer wall of the tympanum. Its plane is not vertical, but slants from above downwards, forming, with the floor of the meatus, an angle of 55°. It is slightly conical, the apex being directed inwards towards the tympanum, and between its layers is inserted the handle of the malleus. It is composed of three layers: an outer, formed by an extremely thin layer of true skin; an inner, by the mucous membrane of the tympanum; and a middle layer, consisting of fibrous tissue; some of the fibres radiate from the centre, others are circular, forming a circumferential ring close to the osseous

groove. The membrane is supplied with blood from the tymp branch of the internal maxillary, the stylo-mastoid branch of posterior auricular, and the Vidian.

Eustachian Tube. For a complete account of the Eustachian t (see p. 186). It proceeds from the anterior p of the tympanum, downwards, forwards, and inwards, to pharynx.

Ossicula Auditus. The three small bones in the tympanum named after their fancied resemblance to cert implements, the *malleus*, *incus*, and *stapes*. They are articula to each other by perfect joints, and are placed that the chain somewhat resemb the letter Z. Their use is to transmit vibrations of the membrana tympani to membrane of the fenestra ovalis, and, throu it, to the fluid contained within the vestibu But they have another use, which would incompatible with a single bone—name to permit the tightening and relaxation the membrane, and thus adapt it either resist the impulse of a very loud sound, to favour a more gentle one.

Fig. 165.

THE OSSICLES OF THE RIGHT TYMPANUM.

A. Malleus. B. Incus. C. Stapes. It lies horizontally and forms a right angle with the long process of the incus.

The *malleus*, or hammer bone, consists of an upper part head, which is suspended to the roof of the tympanum by the s pensory ligament, and articulates posteriorly with the incus. Fr it proceeds the handle, which is nearly vertical, and is attac along its whole length to the upper half of the membrana tymp The long process (processus gracilis) projects at right angles fr the head of the malleus, runs into the Glaserian fissure, receives the insertion of the laxator tympani. The proces brevis, situated at the junction of the long process and the he looks towards the membrana tympani, and receives the insertion the tensor tympani.

The *incus*, or anvil bone, is shaped like a tooth with two uneq widely separated fangs. Its broad part or body presents a conca convex articulation for the head of the malleus; its long proc

runs nearly parallel with the handle of the malleus, and articulates with the stapes through the intervention of a small bone, the *os orbiculare*, which, in adult life, forms part of the long process, but in fœtal life is a separate bone; its short process is directed backwards, and its point is fixed in a small hollow at the commencement of the mastoid cells.

The *stapes*, or stirrup bone, lies horizontally. Its head articulates with the long process of the incus. Two diverging crura pass from the head to the base, which is attached to the membrane covering the fenestra ovalis. The stapedius muscle is inserted into the posterior part of its neck.

The tympanic bones are maintained in their positions by various ligaments. The *anterior ligament of the malleus* passes from the head of this bone to the anterior wall of the tympanum; the *suspensory ligament* descends from the roof of the tympanum outwards to the head of the malleus, and the *posterior ligament of the incus* passes from the short process to the posterior wall near the mastoid cells. The ossicles are connected by an imperfect *capsular ligament*, which passes from the long process of the incus to the head of the stapes; and by another which passes from the head of the malleus to the incus. The surfaces of the bones forming these two little joints are covered with cartilage. The joints have also synovial membranes.

MUSCLES OF THE TYMPANUM.

The muscles, by moving the tympanic bones, tighten or relax the membrana tympani. The *tensor tympani* runs in a canal above and parallel to the Eustachian tube, from the cartilaginous part of which it *arises*, as well as from the apex of the petrous portion of the temporal bone. It passes backwards, and terminates in a round tendon, which enters the front wall of the tympanum through a special bony canal, and is *inserted* into the root of the handle of the malleus. Its nerve comes from the otic ganglion. Its action is to draw inwards the head of the malleus, and thus render the membrane tense. The *laxator tympani arises* from the spinous process of the sphenoid, and the Eustachian tube, and is *inserted* into the neck of the malleus close to the root of the processus gracilis. It is supplied

by a branch of the facial nerve.* Its action is to relax the me brana tympani. The *stapedius arises* from the hollow of t pyramid, and its tendon runs forwards to be *inserted* into t neck of the stapes.† Its nerve is derived from the facial. its action it increases the tension upon the fluid in the vestibule.

The tympanum is lined with mucous membrane, which continuous with that of the pharynx. It covers the ossicles, a is prolonged into the mastoid cells. The membrane is pale a thin, and lined with columnar ciliated epithelium, except on t promontory, the membrana tympani, and the ossicles, where the is only a single layer of flattened cells.

CHORDA TYMPANI. A branch (*chorda tympani*) of the facial ner enters the tympanum through a foramen at t base of the pyramid (foramen chordæ posterius); it then cross the tympanum between the handle of the malleus and the lo process of the incus, leaves the tympanum through a foram (foramen chordæ anterius), and then traverses a canal (*canal Huguier*), which runs close to the Glaserian fissure. It eventual joins the submaxillary ganglion (p. 51).

BLOOD-VESSELS OF THE TYMPANUM. The tympanum is supplied with blood—1, the *tympanic* branch of the internal maxillar which enters through the fissura Glaseri; 2, the *stylo-mastoid* branch of the posterior auricular; 3, by sm branches from the ascending pharyngeal, which enter with t Eustachian tube; 4, by branches from the internal carotid arter and 5, by the petrosal branch of the arteria meningea media.

The mucous membrane is supplied with branches from t tympanic plexus, which is formed by filaments from the tympan branch of the glosso-pharyngeal nerve, from the carotid sympathet plexus, and from the large and small superficial petrosal nerves.

INTERNAL EAR. This, in consequence of its complexity, is call the *labyrinth*. It consists of cavities excavat

* This is usually regarded as a muscle, and is described here as such; no m cular fibres, however, can be traced in it, so that it is probably only ligamentous structure—a fact borne out in the lower animals.

† There is a little sheath, lined with synovial membrane, to facilitate the play the tendon in the pyramid.

in the most compact part of the temporal bone. The cavities are divided into three—a middle one, called the *vestibule*, being a centre in which all communicate; an anterior, named from its resemblance to a snail's shell, the *cochlea*; and a posterior, consisting of *three semicircular canals*. These cavities are filled with a clear fluid, called the *endo-lymph*, and contain a membranous expansion (the *membranous labyrinth*), upon which the filaments of the auditory nerve are expanded.

Vestibule. The *vestibule*, or central chamber, is an irregular oblong cavity, about one-fifth of an inch in its widest part. It communicates in front with the cochlea, through

Fig. 166.

1. The superior semicircular canal.
2. The posterior semicircular canal.
3. The external semicircular canal.
4. Common opening of the superior and posterior semicircular canals.

5. Aqueductus vestibuli.
6. Aqueductus cochleæ.
7. Fovea hemi-elliptica.
8. Fovea hemispherica.
9. Scala tympani.
10. Scala vestibuli.

OSSEOUS LABYRINTH OF THE RIGHT SIDE (Sömmering).

the scala vestibuli; behind, with the five openings of the semicircular canals; on the outside with the tympanum, through the fenestra ovalis; on the inside is a shallow depression, the *fovea hemispherica*, through which are transmitted the branches of the auditory nerve. Posteriorly, this depression is bounded by a ridge, the *crista vestibuli*, and in some subjects there is behind this eminence the opening of a small canal, called the *aqueductus vestibuli*. It leads to the posterior surface of the temporal bone, and transmits a small vein. In the roof is an oval depression, the *fovea hemi-elliptica*, which lodges the utricle.

Semicircular Canals. The *semicircular canals*, three in number, are situated above, and rather behind the vestibule.

Each canal forms about two-thirds of a circle, and is about one-twentieth of an inch in diameter. They open at each extremity into the vestibule, therefore there should be six apertures for them; but there are only five, since one of the apertures is common to the extremities of two canals. The canals are not of equal diameter throughout; each presents at one end a dilatation termed the *ampulla*, about one-tenth of an inch in diameter. This dilatation corresponds to a similar dilatation of the membranous sac, upon which the auditory nerve expands. Each canal differs in its direction; they are named accordingly, *superior*, *posterior*, and *external*. The superior s. c. is also the most anterior of the three; its direction is vertical, and runs across the petrous bone; the ampulla is at the outer extremity. Its non-ampullated extremity

FIG. 167.

1. Scala tympani.
2. Scala vestibuli.

3. Lamina spiralis ossea.
4. Modiolus, or central pillar.

THE OSSEOUS COCHLEA.

opens by a common orifice with the posterior s. c. The *posterior* s. c. is also vertical, runs parallel to the posterior surface of the petrous bone, and consequently, at right angles to the preceding; the ampulla is at the lower end. The *external* s. c. is horizontal in position, with the convexity of the arch directed backwards; the ampulla is at the outer end.

COCHLEA. The cochlea is the most anterior part of the internal ear: it very closely resembles a common snail's shell, and is placed so that the base of the shell corresponds to the bottom of the meatus auditorius internus, while the apex is directed forwards and outwards. Its base is about a quarter of an inch in diameter. It consists of the spiral convolutions of two parallel and gradually tapering tubes, which wind round a central pillar, called the *modiolus*. The partition by which the tubes,

scalæ, are separated is termed the *lamina spiralis*. In the dry bones this partition is only partial; but in the recent state it is completed by a membrane. The spiral canal is about the $\frac{1}{10}$ of an inch in diameter, and is about one inch and a half long, and, after making two turns and a half, terminates at the apex of the cochlea in a rounded dome, the *cupola*. Here the partition disappears, and is called the *helicotrema*, so that the two scalæ communicate with each other in this situation. These tubes are called the scales of the cochlea, and are filled with fluid. The upper one, the *scala vestibuli*, opens into the vestibule; the lower one, rather the larger of the two, is called the *scala tympani*, and leads to the membrane which closes the foramen rotundum of the tympanum. At its commencement there is the opening of the *aqueductus cochleæ*, which transmits a small branch to the jugular vein.

The central pillar of the cochlea is called the *modiolus*. It is of considerable thickness at the base, but gradually tapers towards the apex. Its interior is traversed by numerous canals, which transmit small vessels and nerves to the lamina spiralis. One of these canals, larger than the others, runs down the centre of the modiolus nearly to the apex, and transmits a small artery, the *arteria centralis modioli*.

The *lamina spiralis*, the partition between the two tubes or scales of the cochlea, is made up, on the inner half, of bone, (*lamina spiralis ossea*); on the outer half, of membrane, which, as will be presently described, consists of two layers. The lamina spiralis ossea ends at the cupola in a hook-line process, the *hamulus*. On a vertical section it is seen to be composed of two plates, between which the structure is spongy, and presents a number of small canals for the passage of the small filaments of the cochlear division of the auditory nerve in their course to the membranous part of the lamina. Winding round the modiolus, close to the attachment of the lamina spiralis ossea, is a small canal, called the *canalis spiralis modioli*.

MEMBRANOUS LABYRINTH.

If the bony labyrinth just described be properly understood, there will not be much difficulty in

comprehending the shape of the membranous labyrinth in its interior,—a structure supporting the ultimate ramifications of the auditory nerve. The membranous labyrinth floats in a fluid called the *peri-lymph* or *liquor Cotunnii*, which is secreted by the delicate serous membrane lining the osseous labyrinth.

The membranous labyrinth is a sac, contained partly in the vestibule and partly in the semicircular canals: that situated in the vestibule is termed the *vestibular portion*; that in the bony canals, the *membranous semicircular canals.*

The sac in the vestibule is so constructed as to form two sacs of unequal size, which indirectly communicate with each other.* The larger of the two, called the *utricle* or *common sinus*, is oval, and communicates with the five openings of the membranous semicircular canals. It is lodged in the fovea hemielliptica, and its wall is thickest close to the crista vestibuli, where branches from the auditory nerve enter it. The smaller, called the *saccule*, is globular and flattened, and lies in the fovea hemispherica, in front of the utricle. It is connected with the membranous canal of the cochlea by a small short duct, termed the *canalis reuniens.*

The utricle and the saccule contain on their inner wall a minute mass of calcareous matter in connection with nerve ends, called by Breschet the *otoliths* or *otoconia.* They are crystals of carbonate of lime, and are present in the labyrinth of all mammalia. From their greater hardness and size in aquatic animals, there is reason to believe that they perform the office of rendering the vibrations of sound sharper and more distinct.†

MEMBRANOUS SEMICIRCULAR CANALS.

The membranous semicircular canals present the same dilatations or ampullæ as the bony ones, at one end, and at this part they nearly fill their

* From the utricle there proceeds a small canal, which lies in the aqueductus vestibuli; this is joined close to its commencement by a similar canal from the saccule; thus forming the indirect communication above alluded to.

† For a detailed description of the relation of the otoliths with the hair-like processes of the nerve-filaments, the student is referred to an article by Dr. Urban Pritchard in the 'Quarterly Journal of Microscopic Science,' October, 1876, entitled 'The Termination of the Nerves in the Vestibule, and Semicircular Canals of Mammals.'

bony cases; but in the rest of their extent the diameter of the membranous canal is not more than one-third that of the bony. At the ampullated extremity the sac is connected on its outer aspect by blood-vessels and nerves to the periosteum, forming, on section, a septum, called the *septum transversum.*

The membranous labyrinth is protected, inside and out, by fluid. The fluid in the interior is termed the *endolymph*, and the thin layer between it and the bone, the *perilymph* or *liquor Cotunnii*; thus the delicate nervous membrane is placed between two layers of fluid.

DISTRIBUTION OF THE AUDITORY NERVE.

The auditory nerve or portio mollis of the seventh pair, passes down the meatus auditorius internus, and at the bottom of it, divides into an anterior and posterior branch, which, after breaking up into numerous fasciculi, are distributed to the cochlea and to the vestibule.

The *vestibular nerve* divides into five branches, which proceed to the utricle, the saccule, and the three ampullæ of the semicircular canals, respectively: those for the utricle, and the superior and external semicircular canals enter the vestibule along the crista vestibuli; that for the saccule enters through the fovea hemispherica, and that for the posterior semicircular canal is continued along a bony canal to its termination. The nerves to the semicircular canals enter the ampullæ by a forked swelling which corresponds to each septum transversum.

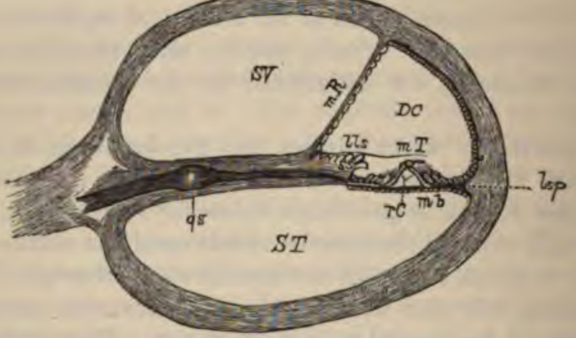
The membranous semicircular canals consist of three layers, an outer or *fibrous layer*, which is connected with the periosteum by blood-vessels, and contains irregular pigment-cells; a middle or *tunica propria*, clear and structureless; and an inner or *epithelial layer*, which lines the inner space of the tunica propria. At the ampullæ the epithelial layer is composed of the columnar variety, upon which are arranged cells of a spindle shape, having delicate ciliated processes (*auditory hairs*) projecting into the endolymph.

It has been stated that in the bony cochlea there is a partial septum, dividing the spiral tube into two incomplete scalæ. In the recent condition, however, the osseous lamina spiralis is continued

outwards by a thick membrane, the *basilar membrane* (fig. 168); thus dividing the tube into an upper canal, the scala vestibuli, and a lower, the scala tympani. The upper scale is subdivided by an oblique membrane—*membrane of Reissner*—into two canals, an inner, the *scala vestibuli*, and an outer, the *ductus cochlearis*. The ductus cochlearis or scala media terminates at the helicotrema in a cul-de-sac; inferiorly it is connected with the cavity of the saccule by a long, narrow duct, called the *canalis reuniens*.

On examining the membranous continuation of the lamina spiralis, it is seen, not far from its attachment to the osseous zone,

Fig. 168.



DIAGRAMMATIC SECTION OF A COIL OF THE COCHLEA.

(From Quain.)

S V. Scala vestibuli.
D C. Ductus cochlearis.
S T. Scala tympani.
m R. Membrane of Reissner.
l l s. Limbus laminæ spiralis.
m T. Membrana tectoria.
r C. Rods of Corti.
m b. Membrana basilaris.
l s p. Ligamentum spirale.
s s. Sulcus spiralis.
g s. Ganglion spirale.

to be thickened into an elongated crest, the *limbus*, which overhangs a groove, called the *sulcus spiralis*. The structure of the limbus consists of firm connective tissue, on the under part of which are found numerous cells. The basilar membrane forms, at the base of the cochlea, but a small breadth of the septum, the broadest part being formed of bone, but it gradually increases in breadth towards the cupola, where it constitutes nearly the entire septum.

It consists of a firm, fibrillated tissue, which is probably formed, at any rate on its upper surface, of a structure closely resembling the organ of Corti.

The membrane which separates the scala vestibuli and the ductus cochlearis is a delicate almost structureless layer, the *membrane of Reissner*. It appears to be composed of connective tissue, lined on its vestibular surface with flattened connective-tissue cells, and on its cochlear surface with squamous epithelium.

At the point of attachment of the basilar membrane with the outer wall of the cochlea may be seen a triangular projection, which, formerly described as a muscle, (*cochlearis muscle*), is now generally believed to be a collection of connective-tissue cells, and called the *ligamentum spirale*.

ORGAN OF CORTI. The *organ of Corti* is a highly complex structure, placed on the upper surface of the basilar membrane, and the floor of the ductus cochlearis. The central part of the organ of Corti is formed by two sets of slanting rods—*inner* and *outer rods of Corti*,* which rest against each other at their upper extremities, thus forming a triangular tunnel beneath them, filled in the recent state with endolymph.

On the inner side of the inner rods is a single row of cells tipped with ciliated processes, called *the inner hair-cells*; and on the outer side of the outer rods are three rows of similar cells, termed the *outer hair-cells*.

The only remaining membrane to be described is the *tectorial membrane*, which lies above and parallel to the basilar membrane, but does not extend much more than half-way over it. It is connected on its inner side with the limbus spiralis, and is then continued outwards, overlying and resting upon the rods of Corti, and ends in a free extremity. It is a strong, elastic membrane, distinctly fibrous, especially upon its inner and thicker part.

The cochlear division of the auditory nerve (the vestibular has already been described, p. 659) is a short, thick branch, which breaks up into numerous filaments at the bottom of the meatus auditorius

* The inner rods are stated to be more numerous than the outer, in the proportion of 6,000 of the inner to 4,500 of the outer rods.

internus. These enter the canals in the base of the modiolus, and then arch outwards between the plates of the lamina ossea. In their course outwards between the plates, they pass through the spirally arranged ganglionic cells, beyond which they form a wide plexus. They are collected together close to the free border of the osseous zone, forming a very minute nerve-plexus, whose filaments interlace freely; they then enter the membranous zone to be connected with the inner hair-cells of the organ of Corti.*

The vessels which supply the cochlea are from ten to twelve in number, and are derived from the auditory artery; they, like the nerves, enter the bony canals of the modiolus, and then turn outwards to ramify upon the osseous zone, supplying its periosteum. The plexus formed by these branches communicates with a vessel known as the *vas spirale*, which runs longitudinally in the ligamentum spirale to the outer attachment of the membrana basilaris. The veins from the cochlea terminate in the superior petrosal sinus, having previously joined those of the vestibule and semicircular canals.

* Some anatomists describe filaments as passing between the rods of Corti to end in the outer hair-cells.

DISSECTION OF THE MAMMARY GLAND.

The form, size, position, and other external characters of the mammary gland vary more or less in different persons. The longest diameter of the gland is in a direction upwards and outwards towards the axilla; its thickest part is at the centre; and the fulness and roundness of the gland depend upon the amount of fat about it. Its deep surface is flattened in adaptation to the pectoral muscle, to which it is firmly connected by an abundance of areolar tissue. In its vertical direction the breast corresponds to the space between the third and sixth or seventh ribs; in its lateral direction, to the space between the side of the sternum and the axilla, while the nipple corresponds to the fourth rib, or a little below it.

It is enclosed by a fascia, which not only supports it as a whole, but penetrates into its interior, so as to form a framework for its several lobes; hence it is that, in cases of mammary abscess, the matter is apt to be circumscribed, not diffused.

The *nipple* (*mammilla*) projects a little below the centre; it is surrounded by a coloured circle, termed the *areola*; this circle is of a rose-pink colour in virgins, but, in those who have borne children, of a dark brown. It begins to enlarge and grow darker about the second or third month of pregnancy, and these changes continue till parturition. The areola is abundantly provided with papillæ, and with subcutaneous sebaceous glands, to lubricate the surface during lactation; the areola as well as the nipple is destitute of fat.

STRUCTURE.

The gland itself consists of distinct lobes held together by firm connective tissue, and provided with separate lactiferous ducts. Each lobe divides and subdivides

into lobules, and the duct branches out accordingly.* Traced to their origin, we find that the ducts commence in clusters of minute cells, and that the blood-vessels ramify minutely upon these cells; altogether, then, a single lobe might be compared to a bunch of grapes, of which the stalk represents the main duct. The main ducts (*galactophorus ducts*) from the several lobes, from fifteen to twenty in number, converge towards the nipple, and, just before they reach it, become dilated into small sacs or *ampullæ*, two or three lines wide; after this they run up to the apex of the nipple, and, running parallel, terminate in separate orifices.

The vesicles and the galactophorus ducts are lined with columnar epithelium, except at their orifices, where it becomes squamous.

The arteries of the gland are derived from the long thoracic, the internal mammary, and the intercostals; the nerves come from the anterior and lateral cutaneous branches of the intercostal nerves and from the descending branches of the cervical plexus. The veins diverge from the nipple, and terminate in the axillary and internal mammary veins.

The lymphatics run chiefly to the axillary glands.

* It is observed, in some cases, that one or more lobules run off to a considerable distance from the main body of the gland, and lie embedded in the subcutaneous tissue. This should be remembered when it is necessary to remove the entire gland.

DISSECTION OF THE SCROTUM AND TESTIS.

STRUCTURE OF THE SCROTUM. THE scrotum is a pouch of skin for the lodgment of the testes, and presents in the middle line a ridge, the *raphé*, on each side of which it is corrugated into rugæ. It is composed of six tunics:—1. The skin; 2. The tunica dartos; 3. A layer of connective tissue; 4. The spermatic fascia; 5. The cremaster or suspensory muscle; 6. The infundibuliform fascia, derived from the fascia transversalis.

Each of these coverings cannot be demonstrated under ordinary circumstances, because they are so blended together; but they can be shown when hypertrophied in the case of old and large herniæ.

DARTOS. The *dartos* is a thin layer, consisting of muscular fibres of the involuntary kind, like those of the bladder and intestines. It serves to corrugate the loose and extensible skin of the scrotum, and in a measure to support and brace the testicles. It is more abundant in the anterior than the posterior part of the scrotum.

LAYER OF CONNECTIVE TISSUE. Beneath the dartos is a large quantity of loose connective tissue, remarkable for the total absence of fat. Together with the dartos, it forms a vertical partition between the testicles, termed the *septum scroti*. It is not a complete partition, since air or fluid will pass from one side to the other. The great abundance and looseness of this tissue explains the enormous swelling of the scrotum in cases of anasarca, and in cases where the urine is effused into it in consequence of rupture or ulceration of the urethra.

The spermatic fascia, cremaster muscle, and the infundibuliform fascia have been described (pp. 359, 361, 366).

TESTIS. The testicle is a gland of an oval shape with flattened sides, suspended obliquely, so that the upper end is directed forwards and outwards, the lower end in the reverse direction. The left is generally a little the lower of the two. Each testis is about an inch and a half in length, and one in breadth, and weighs about six drachms; but few organs present greater variations in size and weight, even in men of the same age; generally speaking, the left is the larger. The front and sides of the testes are smooth, and covered with the visceral layer of the tunica vaginalis; but along the posterior part of the gland

FIG. 169.

1. Mediastinum testis, containing the rete testis.
2, 2. Trabeculæ.
3. One of the lobules.
4, 4. Vasa recta.
5. Coni vasculosi, forming the 'globus major' of the epididymis.
6. Globus minor, or lower end of epididymis.
7. Vas deferens.

DIAGRAM OF A VERTICAL SECTION THROUGH THE TESTICLE.

EPIDIDYMIS. is placed a long narrow body, termed the *epididymis*; this is not a part of the testicle, but an appendage to it, formed by the convolutions of its long excretory duct. Its upper larger end is called the *globus major*, and is connected with the testicle by the efferent ducts; the lower end, *globus minor*, is only connected with the testicle by fibrous tissue; that part of the epididymis between these two portions is called the *body*. A considerable quantity of unstriped muscular fibre exists at the posterior part of the epididymis and testis beneath the infundibuliform fascia, and has been described by Kölliker as the inner muscular tunic.

PROPER COVERINGS OF THE TESTICLE. The coverings of the testicle are—1. A serous membrane, called the *tunica vaginalis*, to facilitate its movements; 2. A strong fibrous membrane, called the *tunica albuginea*, to support the glandular structure within; 3. A delicate stratum of minute blood-vessels, which some anatomists have described as a distinct coat, under the name of *tunica vasculosa*.

TUNICA VAGINALIS. The *tunica vaginalis* is a closed serous sac, one part of which (tunica vaginalis propria) adheres closely to the testis; the other (tunica vaginalis reflexa) is reflected loosely around it. On opening the sac, it will be seen that the visceral layer completely covers the testicle, except behind, where the vessels and duct are situated (fig. 170); and that it covers the *outer* part of the epididymis in front and behind, forming here a pouch called the digital fossa. The parietal layer extends upwards for a variable distance upon the cord. The interior of the sac is smooth and polished, like all other serous membranes, and lubricated by a little fluid. An excess of this fluid gives rise to the disease termed 'hydrocele.'

The tunica vaginalis was originally derived from the peritoneum. In some subjects it still communicates with that cavity by a narrow canal, and is therefore liable to become the sac of a hernia (see diagram, p. 370). Such herniæ are called *congenital*—a bad term, since they do not necessarily take place at birth, but may occur at any period of life, even in very old age.* Sometimes the communication continues through a very contracted canal, open to the passage of fluid alone; or the communication may be only partially obliterated, and then one or more isolated serous sacs are left along the cord. Such an one, when distended with fluid, gives rise to hydrocele of the cord.

TUNICA ALBUGINEA. This tunic is a dense, inelastic membrane, composed of fibrous tissue, interlacing in every direction; analogous to the sclerotic coat of the eye. It completely

* It would be a better term to call this lesion, a *hernia in the tunica vaginalis*, denoting thereby its anatomical position; at the same time implying a congenital arrest in development, and without limiting its occurrence to any age of life.

invests the testicle, but not the epididymis. At the posterior pa of the gland it penetrates into its substance for a short distanc and forms an incomplete vertical septum, termed, after tl anatomist who first discovered it, *corpus Highmorianum*, a subsequently by Sir A. Cooper, *mediastinum testis* (fig. 17 This septum transmits the blood-vessels of the organ, and contai also the network of seminal ducts, called the *rete testis*, shown diagram (fig. 169).

From the mediastinum testis are given off, in all directions number of diverging slender fibrous cords, which traverse t interior of the gland, and are attached to the inside of the tuni

Fig. 170.

1. Spermatic artery.
2. Vas deferens.
3. Deferential artery.

4. Epididymis.
5. Mediastinum testis.
6, 6. Cavity of tunica vaginalis.

TRANSVERSE SECTION THROUGH THE TESTICLE (diagrammatic).

(The dots show the reflections of the tunica vaginalis.)

albuginea. They serve to maintain the general shape of the tes cle, to support the numerous lobules of which its glandular su stance is composed, and to convey the blood-vessels into it. Th septa (trabeculæ testis) as well as the mediastinum from whi they proceed, are readily seen on making a transverse section throu the gland (fig. 170).*

TUNICA VASCULOSA. Respecting the so-called *tunica vasculo* nothing more need be said than that it consists of multitude of minute blood-vessels, formed by the ramifications

* Kölliker has demonstrated unstriped muscular fibres upon the septa as well the mediastinum.

the spermatic artery, and held together by delicate areolar tissue. It covers the inner surface of the tunica albuginea, and gives off branches, which run with the fibrous septa into the interior of the gland.

MINUTE STRUCTURE. When the testis is cut into, its interior looks soft and pulpy and of a reddish-grey colour. It consists of a multitude of minute convoluted tubes—*tubuli seminiferi*—which have each a length of about two feet and a quarter, and a diameter averaging $\frac{1}{170}$ of an inch. For economy of space they are arranged in *lobules*, between three and five hundred * in number, of various sizes, and contained in the compartments formed by the fibrous septa proceeding from the mediastinum testis. A few only of these lobules are shown in the diagram. Though disposed in lobules, still they communicate with each other, and thus form one large network of tubes. The tubuli are lined with flattened cells of several strata in thickness, resting upon a basement membrane. They commence either by anastomosing loops, or by blind dilated extremities, and after pursuing a convoluted course, unite into from thirty to fifty straight vessels (*vasa recta*), which penetrate the mediastinum testis, and there form a plexus of seminal tubes, termed the *rete testis*. This lies along the back of the gland. From the upper part of the rete, the secretion is conveyed to the upper part of the epididymis by twelve to fifteen tubes, termed *vasa efferentia*, which perforate the tunica albuginea in their course to the globus major. These, after forming a number of coils, termed *coni vasculosi*,† collectively constitute the globus major of the epididymis.

At the globus major the smaller tubes terminate in a single duct—the *canal of the epididymis*, which in its descent describes an extremely tortuous coil, constituting the body and globus minor of the epididymis. The length of the canal of the epididymis is, in its natural condition, about three inches, but when unravelled

* The larger estimate is that by Krause; the smaller that by Berres.

† The coni vasculosi are about $\frac{1}{30}$ of an inch in diameter, and about six to eight lines long; when unravelled they attain a length of six to eight inches.

it is nearly twenty feet in length. The diameter of the canal a commencement is about $\frac{1}{70}$ of an inch; at the globus minor a $\frac{1}{90}$ of an inch, after which it again increases in diameter. lined with columnar ciliated epithelium.

VAS DEFERENS. The *vas deferens* begins at the lower part o globus minor; at first it is somewhat convol but as it ascends behind the epididymis, it becomes subseq straight, and joins the other component parts of the cord. passing through the inguinal canal, it enters the abdomen thr the internal ring. It then winds round the outer side o epigastric artery, and, after crossing over the external iliac a and vein, it enters the pelvis, curves round the side and l part of the bladder, and empties itself into the prostatic pa the urethra, after running a course of about two feet.

In connection with the anterior aspect of the cord, just a the epididymis, are two or three small masses of convoluted t which are known as the *organ of Giraldes*, or the *parepid mis*. They are lined with squamous epithelium, and are prob the remains of part of the Woolffian body.

The *hydatids of Morgagni* are one or two small peduncul bodies, situated between the globus major and the body of testis. They are formed by pouchings of the tunica vagin and are filled with blood-vessels bound together by conne tissue.*

The *vas aberrans* is a small convoluted tubule, with a c extremity, found between the epididymis and the cord, and c municating usually with the canal of the epididymis. It is a an inch in length, but when frayed out varies from two to tw inches in length. It, like the organ of Giraldes, is connected a fœtal structure, the Woolffian body.

SPERMATIC CORD. The spermatic cord is composed of the sperm vessels, nerves, and lymphatics; of the deferens, with the deferential artery (a branch of the sup vesical); of the cremaster muscle, and the cremasteric arte

* The largest, which lies upon the top of the testis, is stated to be the vest Müller's duct.

branch of the deep epigastric. It begins at the internal ring, traverses the inguinal canal, and extends to the testis, where its component parts pass to their respective destinations. The coverings of the cord have been described with the anatomy of the parts of hernia (p. 369).

The course of the spermatic arteries and veins has been described in the dissection of the abdomen (p. 403). The artery is remarkably tortuous as it descends along the cord; it enters the back part of the testicle, and breaks up into a number of fine ramifications, which spread out on the inner surface of the tunica albuginea. The spermatic *veins* leave the testis at its back part, and, as they ascend along the cord, become extremely tortuous, and form a plexus termed *pampiniform*. It is usually stated that these veins are destitute of valves; and this fact is adduced as one of the reasons for the occurrence of varicocele. It is, however, certain that the larger veins do contain valves.

The *lymphatics* of the testis pass through the lumbar glands; hence these glands, and not the inguinal, become affected in malignant disease of the testis.

The *nerves* of the testicle are derived from the sympathetic. They descend from the abdomen with the spermatic arteries, and come from the aortic plexus, with a few filaments from the hypogastric plexus, which surround the deferential artery (p. 442). This accounts for the ready sympathy of the stomach and intestine with the testicle, and for the constitutional effects of an injury to it.

DESCENT OF THE TESTIS. The testicle is originally developed in the lumbar region, immediately below the kidney, and is loosely attached to the back of the abdomen by a fold of peritoneum, termed the *mesorchium*, along which its vessels and nerves run up to it, as to any other abdominal viscus. From the lower end of the gland a fibrous cord, termed the *gubernaculum testis* * proceeds to the bottom of the scrotum. There is no evidence to

* Mr. Curling considers the gubernaculum testis to be a muscular cord. See his Observations on the Structure of the Gubernaculum, and on the Descent of the Testis in the Fœtus: 'Medical Gazette,' April 10, 1841.

warrant the assumption that the gradual contraction of gubernaculum effects the descent of the testis. The organ beg to descend from the lumbar region about the fifth month of fœ life, reaches the internal ring about the seventh, and about ninth has entered the scrotum. Its original peritoneal coat retained throughout; but as it enters the inguinal canal, peritoneal lining of the abdomen is pouched out before it, a eventually becomes the tunica vaginalis reflexa. Immediat after the descent of the testis, its serous bag communica with the abdomen, and in the lower animals continues to do throughout life.* But in the human subject the canal of co munication soon begins to close. It closes at the upper extremi first,† and the closure is generally complete in a child born at full time.‡ This provides against the occurrence of ruptures, which man, owing to his erect position, is more exposed th animals. At the end of the first month after birth, the canal entirely obliterated from the internal ring to the testis. Som times, however, this obliteration fails, or is only partial; hen may arise congenital hernia, or hydrocele. The possible existen of a communication between the tunica vaginalis and the peritone cavity of the abdomen, is one reason among many why cauti should be observed in treating hydroceles in children with stim lating injections.

* According to Professor Owen, the African orang outang (*Simia troglodytes*) the only exception to this rule. In this animal it is interesting to observe that lower extremities are more fully developed as organs of support, and there is a lig mentum teres in the hip-joint.

† The frequency of hernia in the funicular portion of the vaginal process of peritoneum hardly bears this out.

‡ Camper has shown, that the canal on the right side is nearly always open birth, whereas that on the left is usually closed. This explains the greater frequen of hernia on the right side in children under one year old. Thus out of 3,014 ca of inguinal hernia seen at the City of London Truss Society under one year, 2,2 occurred on the right side, and 745 on the left; or in the proportion of 3 to 1.

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